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THE SCIENCE OF HUMANITY.*

I.

HUMANITY is a favorite theme of poet and philosopher, novelist and historian, dramatist and moralist. The changes rung on the theme run the entire gamut of human feeling and thinking; its burden is caught in song and story and crystallized in books, and no sweeter strains have ever been sung, no grander scenes enacted, no nobler lines penned, than those fertilized by the touch of human (and solely human) nature that makes the whole world kin.

The chief subject of thought among all races is humanity in some of its numberless aspects; the chief part of the literature of civilized nations relates to humanity; the chief activities of all men are inspired by humanity. Yet—and this is a modern marvel—for the greater part the thought is vague, the literature random, the activity unorganized; *i. e*, this most important of all subjects-matter and objects-matter in human ken has hardly been brought into the domain of that definite knowledge called science. It is meet to inquire why this is so; and, to the end that the inquiry may be answered clearly, it is needful first to define humanity and then to consider what knowledge is and the way in which science has come to be; later the half-formed science

*Vice-Presidential address before Section H of the American Association for the Advancement of Science, delivered at Detroit, August 9, 1897.

of that which is proper to intellectual man and most important to his kind may be outlined.

II.

According to the lexicographer, humanity denotes: (1) the condition or quality of being human; (2) the character of being humane; (3) the character of being well bred; (4) mankind collectively, and (5) secular learning or literature.* The fourth of these definitions connotes Man—the genus Homo, object-matter of the broad science of anthropology—viewed in a distinct way, *i. e.*, as a mass or composite body rather than discrete individuals. The fifth definition connotes but a limited field in a vast domain, and is scholastic, if not archaic; with this sense the term is chiefly used in opposition to divinity, often in the plural form (though there is good precedent for the use of this plural form in a more general and at the same time a more definite sense).† The first three definitions connote a wide range of attributes of Man which, albeit well recognized by all intelligent people, are rarely reckoned among the objects-matter of anthropology, seldom included within the pale of science; yet it is these attributes that especially distinguish Man and set him apart from the mineral, vegetal and animal worlds, and exalt him above the rocks and plants and beasts of simple nature.

Although commonplace, these definitions are worthy of careful consideration in that they summarize the substance of intelligent thought since the beginning of writing—indeed, since its own beginning in the remote unwritten past—and particularly during the era of unprecedented intellectual activity and scientific progress dating from the issue of Bacon's *Novum Organum;* they carry the wisdom of the ages, and especially of these later days during which wisdom prevails as never before. Viewed separately or in connection with contemporary definitions relating to mankind, they indicate general (although vague) recognition of certain specific attributes of Man, not as an animal, but as an ill-defined something known as a human being. When the history of thought condensed into the set phrases of the lexicographer is scanned, it is found that bitter controversy has been engendered by the diverse aspects of Man as seen from opposite sides; the disputants, like the storied knights of old, have admired the object, one as silver and the other as gold, and have done doughty battle in defense of their one-sided vision; the biologist, with eyes trained by observation and reason sharpened by long study of living things, sees the silvern side and sounds trumpet for man as an animal, while the litterateur and statesman and philanthropist are half-dazzled by the golden glory of Man as a thing supernal. The fair conclusion is that both are right as to what they see and both wrong as to what they fail to see; and in the light of this conclusion it is clear—if the general judgment of the body of thinkers is worth anything—that man has an animal basis on which a noble superstructure is borne. The definitions of the lexicographer, who voices the thought of the world, show that among general thinkers the idea of humanity prevails over the idea of animality, while the current literature of science indicates that the idea of animality is dominant in scientific circles; indeed, some writers on anthropology, the Science of Man, restrict the term to knowledge of the mammalian order Bimana, a limitation excluding the essential characteristics of Man as a thoughtful and emotional being and as an integral part of a collective and interdependent assemblage. Any attempt to harmonize these opposing ideas must begin with definite

* Condensed and rearranged from the 'Standard' and 'Century' Dictionaries.

† *E. g.*, in 'The Humanities,' by J. W. Powell; SCIENCE, New Series, Vol. I., 1895, pp. 15–18.

statements of the meaning attached to the essential term by more catholic anthropologists. So Humanity may be defined, by exclusion, as the condition or quality or character of possessing attributes distinct from those of animals, vegetals and minerals; or, by inclusion, as (1) attributes or characteristics confined to human beings, comprising (*a*) the condition or quality of being human, *i. e.*, of acting, feeling and thinking after the manner of human beings, (*b*) the character of being humane, and (*c*) the character of being well bred; (2) mankind collectively; (3) secular learning and literature.

The supreme importance of humanity as thus defined is indicated by the fact that it is the foremost subject-matter of thought and speech and literature among all peoples, its prominence increasing from savagery through barbarism and civilization and culminating in enlightenment. The essential distinctness of humanity as thus defined appears when its serial relations to the other primary objects-matter of knowledge are considered. Just as living things rise above the mineral world by the possession of vitality, and just as animals rise above plants by the possession of motility, so do human beings rise above all other things by the possession of specific attributes rooting in mentality and maturing in the complex activities of collective life; or just as inorganic matter is the basis for the essentially distinct organic existence, so organic matter and processes form the basis for the essentially distinct superorganic activities of human existence. The importance and distinctness of humanity are, indeed, such that it behooves naturalists to recognize a fourth realm or world—to extend science from the great realms of the mineral, the vegetal and the animal into the incomparably broader and richer realm of the purely human; and this extension is the chief end of modern anthropology.

III.

Human knowledge is constantly increasing. The body or aggregate of knowledge is imponderable, and may not be counted or measured or weighed; yet it is an entity of prime importance and of universal recognition. Itself indefinite and varying from mind to mind, the sum of knowledge may be divided, albeit roughly, and analyzed, albeit crudely, and the days and years and centuries of its progress among men and peoples may be so studied that its tendencies, and perhaps even the laws of its growth, may be followed, albeit slowly and uncertainly. Although so indefinite, it is well worth while to try, and try again and still again, to analyze knowledge and trace its progress; for knowledge is the end and aim of intelligence, and human progress is measured not more by increase in knowledge of things than by increase in knowledge of knowledge.

Many students have found it convenient to divide or classify knowledge as individual and common, general and special, empiric and scientific, deductive and inductive, etc., according to the point of view; and these divisions are of use in that they represent first steps in analysis, though it is to be remembered that they are more or less vague or arbitrary, one or both. It may not be bootless slightly to extend this provisional analysis in order to trace more clearly the lines and stages in the growth of intellectual product.

For the sake of gaining clear ideas of relation, it is sometimes useful to project perception by the aid of mental imagery, and thereby to visualize the invisible in the eye of the mind. So the great aggregate of knowledge is often likened unto a numerical sum, or a reservoir or river fed by many affluents; but a better figure may be found in scientific ideation, and the imponderable body may be pictured as an indefinite nebula or plasma, constantly

growing by accretion and constantly undergoing internal change. This plasma may best be portrayed as for the most part unorganized, with partially or completely organized nuclei and nodes and processes here and there; and there is a certain fitness in conceiving the organized tracts as near the surface where the interactions between external and internal are direct and continuous. In this way the intellectual product of the world may be likened unto a nebula, a cloud gathering in a supersaturated solution, an amœba, or a brain; it may be viewed as a chaos more or less advanced on the way toward cosmos. The image is ideal; it serves merely as an aid in grasping and formulating widespread notions concerning knowledge as an elusive and intangible yet vigorously real and important something; but it is not essential to correct understanding of the main facts in the growth of knowledge.

Knowledge is born of the individual brain fertilized by indirect contact with other brains, and is given unto others with a degree of freedom varying with the disposition of the individual and the perfection of his mechanism for conveying thought —gesture, picture, speech, writing, printing; the growth of knowledge keeps even pace with the acquisition of structures and devices for its expression; and it is a pleasant and significant fact that in general the disposition to dispense knowledge grows strong and active just as the dispensing mechanism improves, though usually lagging a little behind, much as the verdure follows the vernal shower. So the stage of individual knowledge is initial, the stage of common knowledge consequent; so also individual knowledge is barren and unproductive until turned into the general fund to increase and multiply an hundredfold; and so, too, there is progressive growth from the initial stage of individual discovery or invention, through many ill-defined yet successively higher and higher steps, well toward the mature stage of general possession. It is needful to observe that the body of general knowledge can never quite equal the aggregate knowledge possessed by individuals; although stimulated by others, each active individual knows something more than he is able to tell, be he never so free in disposition and facile in expression; and it is the never-ending process of coining and issuing and exchanging the precious product of the cerebral crucible that gives rise to intellectual property-right, and at the same time enriches the great plasma of knowledge and maintains the activity essential to its existence. It follows—and this scientific certitude may be commended to a certain class of socialistic schemers—that the relation between individual knowledge and general knowledge is asymptotic, in that, although the latter constantly approaches, it never can reach the former; indeed, if general knowledge were ever to overtake individual knowledge, through suspension of the laws of intellectuality (undoubtedly immutable as those of vitality), the special province of mental activity would be annihilated and the body of knowledge would sink into quiescence—and, in the intellectual as in the vital, quiescence is death.

As knowledge is produced and given unto others, the freedom of giving is governed by numberless conditions, including the perfection or imperfection of the mechanism for expression, the avidity or indifference of the chosen beneficiaries, and the price fixed by custom; and so it happens that certain discoveries and inventions are directly communicated only to limited groups of individuals, who thereby accumulate special knowledge. In this way cliques and trades and guilds arise and the germ of caste is planted; in this way, too, specialists grow up through the indifference of the masses and their inability to keep pace

with the investigator whose energies are directed along a single line; and eventually, among the most enlightened peoples, special societies are formed for the purpose of fostering or diffusing discovery and invention and thereby rounding out the fecund plasma of human knowledge. It may be noted that special knowledge is nearly as barren and unproductive as individual knowledge, and is soon blasted by the poison of its own egoism, unless the richer part of its substance is guided toward the general mass, to do work as it advances; for it is by no means to be forgotten that the activity of the great body of knowledge culminates in the province or zone of special knowledge, and that herein lies the leaven that leavens the whole.

During recent centuries, and especially during recent decades, specialists engaged in creating knowledge have studied knowledge itself in the hope of learning its nature and origin; and most of these students have become convinced that the basis of real knowledge is found in the facts of the cosmos as revealed by observation or established by experimentation. So the acquisition of knowledge begins with noting particular facts and advances to assembling or grouping these facts, *i. e.*, proceeds from observation to generalization; the second process involves the elimination of the unlike or incongruous, and this leads to discrimination and to the recognition of analogies. In general terms, and somewhat provisionally, it may be said that the analogies so recognized constitute laws of occurrence, which may themselves be generalized, and that the requisite discrimination of analogies leads to the recognition of homologies, or laws of occurrence and sequence combined; the framing of analogies and homologies being legitimate inference, which develops in hypothesis and matures in theory or doctrine to be finally formulated in laws or principles. Knowledge produced in this regular and simple manner is commonly called inductive, though there is always a deductive element coming over from that general intellectual possession by which even the closest specialist is guided in greater or less measure. Now, it is to be noted that acquisition of knowledge is largely spontaneous and unconscious; that apperception lags far behind perception, and that only the adolescent and mature among men and peoples are clearly conscious of their own mental processes, or, indeed, of the existence of mental process; it follows that most of the processes just outlined are ill-recognized or not recognized at all, even by the very makers of knowledge. Moreover, the later steps in intellectual acquisition are commonly the first to be consciously noted, so that the majority of men, even unto the present day, have failed to recognize the true source of real knowledge, and have appealed to all manner of mysterious and extravagant sources for part or all of the intellectual wealth of the world; for while the more complex processes alone were recognized inference was exalted and observation was contemned, subtle imagining ran riot and overshadowed sober reason, and scholastic learning—which the practical makers of progress fortunately ignored or repudiated—grew into a labyrinth of deductions from vain postulates and hazy lucubrations. A new epoch dawned when Bacon formulated the inductive method, though he knew not that the method was old as the human mind and that he but recognized that which all men do, whether consciously or unconsciously. Reviewing the course of intellectual acquisition from observation through generalization and inference and theory unto laws of occurrence and sequence, knowledge may be classified by degree of development, and the simpler and more primitive (whether burdened by assumption or not) may be called empiric,

while the more definitely organized product of special study may be called scientific; and, remembering that the processes of acquiring knowledge are partly unconscious, that portion which is organized unconsciously may be classed as common sense, or sagacity, or the wisdom of experience, while the consciously organized portion may be called science. This summary of the mode of organizing knowledge may be trite, yet it serves to show that the methods of the student of humanity are in no wise different from those pursued in the physical and natural sciences.

In brief, knowledge is ever passing from the individual to the common and from the special to the general, and thereby its quantity is constantly increased and its utility extended; during recent times it is passing also from the empiric to the scientific, and therefore its quality is improved and its beneficence multiplied.

IV.

When the history of the class of knowledge called science is scanned certain tendencies or directions of growth are perceived, and scrutiny shows that these tendencies are in harmony with the course of development of knowledge in general.

1. In general, observation and research begin with the rare or remote and proceed toward the common and the near. This tendency is revealed when the several branches of science are compared. Perhaps the oldest science is Mathematics, which began before history, so that its origin is obscure and cannot certainly be traced to definite objective basis; but the nearly contemporary and closely related science of Astronomy rested on observation of the celestial bodies, though the observation was long clouded by the mysticism of astrology. Then, as wits were sharpened by mathematical research and astronomical observation, exact knowledge was gradually brought down to nearer bodies and under the guidance of everyday observation, and thus the science of Physics arose so gradually and inconspicuously that its early history is lost. Later, shrewd hermits and beldams wrought magic by means of rare substances, and alchemy grew up; and as time passed the manipulations were extended to common things and the ban of secrecy was gradually broken, and so Chemistry arose. These four branches of knowledge concerning the inorganic interacted with mutual benefit, and for several centuries constituted science, in contradistinction from the vast body of vague thought comprised in scholasticism and folk-lore and from the more useful body of commonplace knowledge not yet consciously organized. Still later, attention was attracted by things nearer to mankind in place and character, and first plants and afterward animals were studied systematically, and Botany and Zoology arose; but for a long time the most attractive organisms were the unusual and therefore striking, or specimens brought by travelers from distant lands; indeed, even during the present half century scientific museum administrators are embarassed by the tendency of the collector to neglect the common and collect the unusual in his own locality, and it is only within a generation or two that the ordinary plants and animals supplying mankind with food and clothing and other everyday commodities have been subjected to scientific research. In like manner, the science of Geology began, soon after botany and zoology, with the study of rare minerals and the ancient rocks of remote mountains; gradually the research extended to the nearer hills and valleys and the later formations, and it is only within the present generation that the soil-making deposits on which human life so largely depends have been brought under scientific examination. Last of all, the scientific research beginning

with the stars and passing to minerals and plants and animals, and through the soil on which plants and animals live, reached man himself; yet the studied observation began not so much with fellow-citizens or fellow-subjects bound to the student by ties of consanguinity and affinity as with the abject savage or half-clad barbarian of distant lands; and even to-day, and in the most enlightened nations of the earth, the pictures brought up in most minds by the term Anthropology are those of alien and inferior peoples, or of human curiosities and monstrosities exhibited in midway plaisances, if not in circuses and dime museums. Even in scientific circles—yea, among those ranked as anthropologists—there are many who habitually restrict the term to the purely animal side of Man, and and ignore that broader and nobler side which distinguishes mankind from all other things. So, whether science be viewed in general or detail, it is found that its progress is toward the ego—toward the everyday and commonplace, perhaps, yet ever toward the more important because nearer, the more useful because the commoner; and the more nearly it approaches the more clearly it is seen that science dignifies both student and object of study—that exact knowledge, with Midas touch, turns dross to gold.

2. In general, research begins with the abnormal and proceeds toward the normal. Judging from the habits of present-day barbarians among whom the tempest is studied and the zephyr ignored, the comet remembered and the planet forgotten, the pre-Chaldean astronomers based their first celestial observations on the erratic wanderers rather than the orderly travelers of the sky; and in all ages prodigies—the bizarre and ill-formed, the gigantic and dwarfish—have been the first to catch and the longest to hold attention, among casual observers and specialists alike. This tendency toward noting the abnormal, like that of regarding the rare rather than the common, is the easily besetting sin of the touring naturalist and local museum collector, the joy of the unscientific and the despair of the scientific among museum administrators. Clearly seen in geology and zoology and botany as the vestige of a primitive past, this tendency to perceive only the abnormal is still strong—indeed almost dominant—in the younger science of anthropology; to-day distorted or wounded or cachectic skulls from the ancient ossuaries of Africa or the huacals of Peru are esteemed far above normal crania of a normal people who have by normal activities aided in making civilization and ennobling the world; to-day the platycnemic tibia and perforate humerus of questionable significance are exalted above the normal members occupied in the march of progress and the conquest of lower nature; to-day there are a flourishing sub-science called criminology and a fantastic fad of extolling and magnifying degeneracy, while the upright in mind and the sound in body are relatively neglected; yet this apparently morbid taste but reflects a tendency of the human mind, and is the promise of better things when the intellect awakened by the abnormal acquires the power of appreciating the normal. Unremembered milleniums of mystical shamanism were required to produce pathology and therapeutics, and centuries of pathology were needed to produce sound physiology and etiology, and in like manner there were generations of mystical and irrational psychomancy before students were able to recognize a basis for the modern and most promising science of psychology. It smacks of the paradox to say that the beginning with the abnormal is the normal course in the making of science; yet the history of each and all of the sciences shows that observation on the abnormal has always led attention to the normal, just as observation on the remote

has ever guided attention toward the near; and it is but natural that the youngest of the sciences should yet retain vestiges of undue magnification of the abnormal.

3. In general, scientific determination proceeds from the qualitative to the quantitative. The tendency is displayed by every branch of science, and so conspicuously that it may be deemed characteristic. It is in accordance with this tendency that estimate precedes weighing and reconnaissance goes before surveying; and it is under the same tendency that scientific progress involves constantly-increasing refinement in observation and ever-growing accuracy in definition.

4. In general, scientific interpretation proceeds from the formal to the physical,* from the material or the inert or the static to the dynamic. The positions and movements of the moon and planets were determined with fair accuracy before Newton discovered that the paths of these and all other celestial bodies are fixed by gravity; when this discovery afforded the means for determining position and movement with incomparably greater accuracy. The physical and chemical effects of heat were recognized for generations, and were ascribed to the hypothetic element phlogiston or the imaginary fluid caloric long before Juole and others found it to be merely a manifestation of molecular motion; whereupon physics and chemistry were revolutionized and the forces of nature were gradually harnessed many times more effectively than before.

The ancients recognized vitality and ascribed it usually to a material something joined to the matter of the body. Some twenty-four centuries ago sagacious Heraclitus conceived life as a universal fire, and less than five centuries ago Paracelsus, and after him van Helmont, wrote of the anima mundi, or archeus, having in mind a vaguely imponderable thing akin to the so-called astral body which votaries of an oriental belief imagine themselves able to materialize out of the depths of transcendental revery; two centuries ago Hoffmann and other anatomists spoke habitually of the vital fluid as contemporary physicists of of phlogiston, and within a hundred years leading physiologists, like Hunter, thought and wrote of a 'diffused vital material;' less than a quarter-century ago Barker was deemed bold unto recklessness for undertaking to correlate vital and physical forces,* and many heads were shaken doubtfully when, in his presidential address before the American Association at Boston in 1880, the same brilliant experimentalist argued from the applications of Mosso's plethysmograph that mental force also may be weighed and measured, so that it must be regarded as inter-convertible with other forms of energy;† yet half a generation of organic chemistry and physics has established these revolutionary propositions beyond peradventure, and introduced a new era of biologic research.

The tendency toward dynamic interpretation is well shown, too, in geology. In the infancy of the science, formations and the extinction of faunas were ascribed to extra-natural cataclysms, the opening of valleys and the shaping of hills to ill-conceived or inconceivable catastrophes; with Lyell—a personal associate of scientific men now living—came the doctrine of uniformism, under which it is recognized that existing rains and rivers and silt-distributing waves are competent to produce the

*As defined by Le Conte in a notable article 'On the Structure and Origin of Mountains,' *American Journal of Science*, third series, Vol. XVI., 1878, page 107.

* 'The Correlation of Vital and Physical Forces,' University Series, Number 2 (Van Nostrand), 1875.

† Proceedings of the American Association for the Advancement of Science, Volume XXIX., 1881, page 12 *et sequentia*.

land-forms and formations of the earth, provided time enough be allowed them; the present generation of geologists, beginning with Powell and including two score others, have scanned the pages of the Great Stone Book, so well laid open by Colorado and other rivers, and have learned to read earth-history from land-forms as well as formations, and have shown that at least a portion of those earth-crust movements which were sheer mystery to Lyell result from the slow transfer of rock-matter by the action of running water. As interpretation grew definite and the mystery of earth-making dissolved, the classification gradually changed from chiefly material or static to chiefly dynamic; for a time the formations were classified by the processes of accumulation; and now the foremost geologists classify earth-science primarily by the great agencies of earth-making.

In anthropology interpretation has not yet grown definite and there are nearly as many modes of interpreting as there are men to interpret, yet even in the short and complex history of this youngest of the sciences the general tendency appears; for the earlier classifications were based on bodily or somatic features, while the more advanced among current classifications rest either on collective attributes or on the activities of the human groups—*i. e.*, the older classifications indicate what men are, the newer indicate what men do. Only half a generation past was it definitively suggested that human mentality is a form of energy, but already the testimony of the plethysmograph has been corroborated in so many ways and so widely extended that most scientific students of mental phenomena assume, either explicitly or implicitly, the essentially physical character of intellectual action; and in this writing it is assumed that intellectual energy is paramount in that it is able to control other forms of energy and make conquest of nature through invention and construction, and the faculties and works of man are classified and interpreted accordingly.

So in astronomy and physics and chemistry, and equally in biology and geology, the progress of science may be measured by the ever-increasing recognition of the dynamic aspect of phenomena, of the physical forces by which the material things are moved; with the recognition of inherent energy or motion, observation progresses from the merely qualitative to the quantitative, and constantly increases in refinement; and in view of this progress in other sciences it can hardly be regarded as premature to attempt the extension of quantitative measure and dynamic interpretation to that side of anthropology which deals with the purely human attributes.

5. In general, scientific interpretation progresses from the stationary to the sequential; for the idea of action engenders the idea of succession. The Chaldean shepherd, the Egyptian soothsayer and the Peruvian priest, like the earlier oriental astrologer, probably first took note of the celestial bodies as striking features of the cosmos, and later observed their rhythmic procession with such care that cycles were established and eclipses and other prodigies were foretold long before the true structure of the solar system was understood. These ancient observations and interpretations must have implanted that idea of the uniformity of nature which has borne so splendid fruit during the present century; the budding notion found poetic expression in pleasing fancies of firmaments of crystal and the music of the spheres; yet it was not until the germinal idea was fertilized by the Newtonian law that the marvelous measure of celestial rhythm came to be known. Led by the planless experiments of daily toil, the mechanic—forerunner of the physicist—was the next to lay hold on the notion of uniform succession; it grew

with the centuries and spread into the neighboring domain of chemistry, where it vitalized the dynamic interpretation of chemic union and aided in producing Avogadro's law, which, according to Cooke, 'holds the same place in chemistry that the law of gravitation does in astronomy'* and forms the basis of what has justly been called the New Chemistry. This law, like all others in science, afforded a means of prevision, or of presaging the unknown in terms of the known, and thus of testing its own validity; and as test followed test the idea of orderly succession grew until, with the aid of refined observation and the guidance of special experiment, it matured in the doctrine of the persistence of motion, the keynote of modern science. Here was a vantage point from which the astronomer was enabled to study the celestial bodies, especially our own sun, not merely as masses, but as chemical and physical assemblages; and so arose the line of research sometimes called celestial physics, but defined and dignified by Langley as the New Astronomy,† which has already afforded a means of analyzing the constituents and measuring the movements of several among the myriads of other suns than ours. True, each of these strides in the advance of physical science represents progressive appreciation of cosmical forces; yet still more fully do they represent progress in recognizing orderly sequence and causal succession in the movements of molar and molecular bodies.

Borrowing from physical science trenchant ideas concerning force and succession, even the earlier biologists analyzed the mechanism of living things and slowly stripped away the primitive panoply of mystery or divinity in which the infantile imagination, whether of men or races, has always enveiled vitality. Lamarck was one of the first to extend the idea of orderly succession to organisms, and, although his special hypothesis of development has fallen into abeyance, it has features which anthropologists do well to remember; then came patient Darwin and doughty Huxley and studious Spencer with the definite doctrine of organic evolution, which spread from man to man and from land to land, producing the greatest and quickest intellectual revolution in the history of the world. Albeit revolutionary, the Darwinian doctrine was but the biotic complement of the physical doctrine of the persistence of motion, and the two doctrines are twin buttresses on which the symmetric structure of modern science is supported. Through the latter doctrine the world and the things thereof were transfigured in a new beauty and perfection, the universe was invested with a new glory, and the narrow notion of breaks in the uniform course of nature by special fiat lost hold on the scientific mind forever.

It chanced that while the ferment of evolution was still fresh a trio of American geologists (Powell, followed by Gilbert and Dutton) entered the inspiring region traversed by Colorado Canyon, and before their work was done the germ of geomorphy, or the New Geology, was planted. It was realized more clearly than ever before that the hills are not everlasting but everchanging, and that the features of every landscape tell an eloquent tale of continental evolution in which competent cause and commensurate effect follow ever in ceaseless succession through the eons of earth-making. The task of the geologist is not ended, indeed is only well begun; yet here as in other sciences the reign of law is realized, and the day of appeal to chance is past.

When Huxley sought 'Man's Place in Nature,'* and still more when Darwin

* 'The New Chemistry' (International Scientific Series, VI.), 1875, page 13.

† 'The New Astronomy,' 1888, chapter 1.

* First publication in 1863.

traced 'The Descent of Man,'* the fruitful idea of the uniformity of nature was pushed into the domain of anthropology, and has now guided for a generation those branches of the science which deal with the animal side of Man; it is true that the rhythmic sequence of cause and effect has hardly been extended so far as to cover the delicate and elusive attribute of humanity, but this extension is the motive of many investigators, the aim of the present writing. Already the broad realm of humanity is fairly defined, and the distinctive form of developmental succession proper to this realm is fairly outlined, so that the distinctness of the science of human attributes has been made clear; for while stellar and molecular and organic development are evolutionary in that the main tendency of change is toward differentiation, the development of humanity is involuntary in that the main tendencies are toward integration and combination. Conformably to the fundamental facts of the great realms of nature the earlier sciences are largely, perhaps chiefly, analytic, while the science of humanity is largely, perhaps chiefly, synthetic; and its votaries seem to find reason for figuring it as the central dome crowning and conjoining the separate columns in the ideal pantheon of science. If the confidence of the votaries is just, the youngest of the sciences may be expected to repay with interest all that it received from the several branches of knowledge whence it sprang; already, indeed, it has thrown light on the course of organic development through researches on the human body, and has begun to guide the acquisition of knowledge through researches on the human brain and its functions; already it is contributing to the physical sciences, *e. g.*, through the refreshing Powellian doctrine of conservation, or of common persistence of motion and matter in the ultimate particle, whereby ideas concerning the mechanism of the universe would seem to be immeasurably simplified and extended; and there are other ways in which the youngest science is daily contributing to the stock of definite knowledge; their name is legion.

So it is that science has always progressed from the rare to the common, from the remote to the near, from the abnormal to the normal, from the merely qualitative to the quantitative, from the merely material aspect to the physical aspect, from the primitive faith in fixity to living realization of causal succession. At first sight this progress may seem puzzling, even paradoxical; yet the general course is but an expression of the order of intellectual operations pursued in scientific research. The first step is observation, which is easy when the objects observed are isolated or distinct, increasingly difficult as the objects increase in number and similarity; the second step is generalization, which is relatively easy when the objects examined are few, relatively difficult when they are many; while the ancillary process of discrimination of the incongruous likewise grows laborious with the multiplication of objects and similarities. Accordingly it is easy to study the rare, the remote and the abnormal, and as faculty is strengthened by exercise, it gradually becomes easy to progress toward the common, the near and the normal. So, also, qualitative determination is easy, quantitative determination difficult; indeed, exact quantitative work is impossible without careful training, as numberless surveyors and teachers can testify. In like manner, interpretation in terms of the material, coupled with appeal to the supernatural when obstacles are encountered, is relatively easy and characteristic of the indolent or immature mind, while the firm grasp of

* The first edition of this notable work appeared in 1871.

analogy and homology, and the clear recognition of energy and sequence, require both native capacity and systematic training. Accordingly, scientific interpretation in terms of action and succession is the end of mental effort and may be regarded as the highest expression of intellectuality. This correspondence between the method of research and the history of science throughout the centuries amply attests the excellence of the method. Yet it is not to be forgotten that just as intellectual grasp strengthens, so interpretation is simplified, partly through the elimination of that question-begging mysticism which pervades all primitive philosophies, partly through clearer arrangement of facts and relations; and as interpretation grows simple three especially noteworthy effects follow: (1) Each step in interpretation makes the later steps easier; (2) as the labor lightens, more energy is left for the next task, and the mind of the student pushes into new fields of study and from time to time organizes new branches of inquiry; and (3) with each extension of inquiry mental faculty is stimulated and strengthened. These tendencies are clearly indicated by the birth and growth of new sciences recorded in the history of research; beginning with the celestial bodies it has extended to mechanical bodies, vegetals, animals, the earth itself, then to the human body, individual and collective; and now it is reaching out toward the special attributes of mankind, the things nearest to human welfare and happiness.

V.

The domain of Anthropology is vast, and, partly by reason of its very magnitude, is sometimes deemed indefinite; yet in the light of the history of science in general its limits and subdivisions may easily be outlined.

History and analogy combine to show that the study of Man began with wounds and diseases and grew into surgery and medicine, which were at first thaumaturgic, but gradually became rational or scientific;* and in this way definite knowledge of the human body gradually accumulated and Anatomy and Physiology, with various ancillary sciences and sub-sciences, took form and function. Meantime the organs of the human body were compared and identified with those of beasts and birds (which were long the better known), and comparative anatomy was established; but it was not until observation and generalization were fertilized by scientific zoology that the study of structures in their functional aspect took shape in Morphology. Under the influence of humanitarian therapy and the unprecedented stimulus of the Darwinian doctrine of development the investigations of the last century, and particularly of the last quarter-century, have extended from structures to functions, and these, through the fruitful science of Embryology, to human ontogeny and phylogeny—to the individual and generic evolution of Man considered as an animate organism. Accordingly there are several branches of science which deal alike with the human organism and the various other animal and even vegetal organisms of the great vital series in which Man is usually, though not invariably, considered the culminating and crowning form. Here anthropology and biology blend; but it is convenient and desirable to distinguish that division of the Science of Man which deals with the organic features of the order Bimana, and this science or subscience is frequently called *Somatology*. Although the oldest and the simplest among the divisions of anthropologic science Soma-

*The genesis and development of surgery, and incidentally of medicine, are discussed in a memoir on 'Primitive Trephining in Peru,' Sixteenth Annual Report of the Bureau of American Ethnology, 1897, especially on pages 19 and 72.

tology comprises various special branches of knowledge commonly classed as sciences, including Pathology, Physiology, Etiology, etc., representing the specific methods and purposes of particular classes of investigation.

The early books and maps of civilized nations show that explorers and pioneers were profoundly impressed by the far-away peoples encountered in their wanderings; there are not only accounts but pictures of headless men with faces in their chests, of cyclops with single eyes set skyward, and of other impossible monstrosities in human semblance; even since zoology became fairly definite, accounts of ten-foot giants in Patagonia and three-foot pygmies in Central Africa and other lands remote or hidden have gained currency and credence. As exploration continued, the unconscionable extravagancies of vision were gradually corrected, and the explorers came to see alien races in proper form and something like proper stature; yet the interest in the stranger peoples remained unabated and led to systematic observation and record. Borrowing methods from biology, the observers or their interpreters sought to classify the men of different continents and provinces and islands by somatic characters —by stature, color of skin, color and texture of hair, color and attitude of eyes, form of feature, form and size of skull, peculiarities of long bones, etc.; and, as the researches became definite and fruitful, they were combined in a science of races called *Ethnology*. This science has much in common with biology, and is a direct outgrowth from that group of sciences pertaining to the human body combined under the term Somatology.

After centuries of unscientific and unsuccessful search for the seat of the soul through baseless deduction and blind introspection, certain thinkers began to profit by contemporary researches in anatomy and physiology; and as eye and mind were trained—even as the eye and mind of the traveler were trained not to make monstrosities out of unfamiliar races—the form and function of the nervous system were gradually recognized, and the dominance of the brain was finally established. Only within a generation or two has the brain been investigated in a scientific way and with due appreciation of the importance of that marvelous structure preformed in the articulates, potentialized throughout the long line of vertebrates, and perfected in the ultimate mammalian form of the genus Homo; yet during the present quarter-century the research has been organized in a science already cultivated in many lands and taught in most of the leading universities. The earlier promoters of this science approached the subject haltingly from the speculative or deductive side, and perhaps for this reason the science is named not so much from the organ itself as from its product, *Psychology*. This modern science is not to be confounded with certain fantastic notions sometimes foisted under the same designation which do little more than obstruct progress; the parent stock of the science was indeed speculative—as is most knowledge in the beginning—but so soon as the graft of somatology was affixed it became fruitful. It is to be noted that while Somatology is essentially biotic, and Ethnology is biotic in so far as it rests on bodily features, Psychology pushes beyond the domain of biology proper, partly in that the human brain owes its perfection of development to the essentially human attributes, partly in that the science, as commonly defined, embraces both brain and mind—both organ and product.

So there are three well-established and and widely recognized sciences whose object-matter is Man considered as an organism; by some students, especially those of past decades, they are held to constitute

the whole of anthropology; by others they are combined as physical anthropology and regarded as including only the animal side of man, but excluding nearly the whole of the essentially human side—nearly, but not quite, the whole, since the field of psychology is common ground. This is the view of several modern anthropologists, and is that held in this writing.

VI.

Passing from that portion of the domain of anthropology which deals with man as an animate genus, there is found another and still broader portion occupied by that which man does as a sentient, volitient and intelligent being; it is true that this portion of the domain is less definite than the other, yet, in the light of intellectual progress, its limits and subdivisions also may be outlined, albeit in some measure provisionally.

The early explorers who came home laden with travelers' tales sometimes brought also more tangible cargo in the form of strange wares; and so the handiwork of the world gradually came under the observation of students, and in time museums were built largely to accommodate the constantly increasing collections of primitive and alien arts. Meantime observant persons in many countries were attracted by relics of archaic culture in the form of implements, weapons, ornaments, apparel and habitations, as well as burial places sometimes containing the bones of the ancient artisans, and these, too, were collected, and museums were built to accommodate them in connection with the artificial material gathered among the living peoples of distant lands. As collectors and collections multiplied, the work was organized; and, although the initial stimulus came from observation in remote countries, the interest grew inward—as is the way of advancing knowledge—and the local research for the rare relics of past ages was the first to receive name and character as the science of Archæology. As observations multiplied, resemblances were found between the culture-products of remote times and remote places; the arts of primitive peoples were found to vary in a manner corresponding more or less closely to race, and thereby ethnic research gained new impetus and served in turn to guide research in the prehistoric. So archæology and ethnology became mutually helpful and grew apace and came to be intimately associated in most minds, despite the fact that the one is concerned primarily with what man is, the other with what man does; and in some circles these branches of inquiry came to be regarded as constituting the whole of anthropology.

At first the products of ancient and alien handiwork were accepted at their token value, much like the chemic elements before Avogadro, the planetary movements before Newton, our sun and others before the doctrine of the persistence of motion, the organic species before Darwin; but within a generation or two it has come to be realized that they possess an innate value as exponents of intellectual activity —as medals of human creation collectively attesting the birth and growth of discovery and invention, design and motive, and all other human faculties. Perhaps the time has not come for defining this stage in the progress of anthropology; it may be that the transition is not yet complete, or that the relations are too complex for easy grasp; yet it seems clear that when the anthropologist first saw in the implement of shell or stone an index to the mental operations of the implement-maker hardly less definite than the written page to the thought of the writer, the Science of Man rose to a higher plane with a bound comparable to those marking great epochs in the development of the other sciences.

Now, in science, each advance gives a new standpoint from which a broader view may be gained; and with the recognition of what may be called the dynamic aspect of artificial objects the way was prepared for further progress. It was soon perceived that the simplest devices are supplements to or substitutes for bodily organs—that the knife of shell or tooth or stone is a supplement to teeth and nails; that the hammer-stone multiplies the efficiency of blows, and that the missile is equivalent to an indefinite prolongation of reach; and accordingly it was realized that, in so far as he is a maker and user of implements and weapons, even the lowest savage rises above the plane of purely animal life. It was next perceived that even the simplest devices react on the organism in various ways. The substitution of the shell knife for nails and teeth diminishes the exercise and hence the vigor of these organs and removes them from the category of characters subject to development through the survival of the fittest in the strife for existence, so that in so far as he employs devices in lieu of organs the savage passes beyond the realm of organic development by natural selection; at the same time the exercise of making and using artificial devices in lieu of natural organs tends to develop distinctively intellectual or cerebral characters, so that the effect of competition in the use of devices is not only to remove Man from the realm of the biotic, but to set him on a new course in a different realm—the realm of the artificial or essentially human. As the view of the artificial continued to broaden it was perceived that while the simpler devices may appertain to individuals they are not integral parts of the individual, like the organs which they supplement, but may and do pass from hand to hand and from group to group; also that the use of a device by one person prompts others to acquire and use similar devices, which they are able to do immediately through mere exercise of individual volition (rather than slowly through generations of natural selection), so that each discovery or invention is at once the germ of a line of devices and a stimulus to intellectual power; and thus it was recognized that there is a strong communal tendency in the realm of the artificial—that the development of devices tends toward interchange and cooperation, yet ever of such sort as to augment intellectual power and elevate the human above the sub-human.

In the light of the dynamic interpretation of devices it is easy to perceive the trend of superorganic succession, or development of the artificial, and to contrast it with the course of biotic evolution. The substance or substratum of the latter is living matter; that of the former any matter, living or dead, with which man chooses to deal; the mode of this is slow elimination of the unfit and unpremeditated survival of the fit, the method of that is immediate imitation and designed improvement of the ingenious; the tendency of biotic evolution is toward organic differentiation, that of artificial development mainly toward organic persistence with endless multiplication and integration of devices; the effect of the one is individual or egoistic, that of the other communal and altruistic. With the recognition of the dynamic and successional aspects of artificial devices, anthropology gained a new significance; for to its objects-matter in the form of the human body and human races and the human brain there was added the whole series of artificial devices and the exceeding potent intellectual activities which these devices represent; and this addition is the basis of what is here styled the Science of Humanity.*

* The enlargement of the domain of Anthropology as here set forth is regarded as marking the most important epoch in the development of this science, one of the most important in the development

VII.

When artificial devices were interpreted in terms of activities a new classification of human handiwork arose. At the same time the activities themselves became objects of research, which soon passed beyond the collections and extended to the multifarious material devices in daily use among living peoples in the various stages of civilization from savagery to enlightenment; still later the research was extended to the intellectual or non-material devices which preeminently distinguish mankind, such as law and letters and learning in their numberless aspects. The study of the activities is now sufficiently advanced to indicate, at least provisionally, their relations among each other and to the merely organic processes; they may be arranged in the order of their affinity with the vital.

The primary activities of mankind are connected with more or less spontaneous sensations of pleasurable character. They arise and expand in fairly definite order; among known primitive peoples they appeal chiefly to the senses, and among more advanced peoples they appeal largely to the emotions and the purely intellectual faculties; they root in sports, games and decorations, and mature in the fine arts of painting, sculpture, the drama, poesy and music, *i. e.*, they constitute the esthetics. The artificial devices growing out of these activities go far toward filling those museums of the world devoted to archaic and ethnic material, and nearly a third part of current anthropologic literature is devoted to this class of objects and the activities which they represent. The activities and activital products form the object-matter of a broad and fruitful field of inquiry known of late as *Esthetology*.

2. Intimately connected with the primary activities, and also originating in spontaneous vital processes, though becoming dominant only by organization through exercise and volition, there are other activities tending toward the maintenance of physical welfare. From a simple beginning in occupations akin to those of the beasts, they arise and expand with each step in cultural advancement from savagery to enlightenment; at first confined to food-getting, they extend also to the making of apparel, the building of habitations, and eventually to the supply of intellectual demands, *i. e.*, they constitute the industries of common parlance. The material devices growing out of the industrial activities have enriched anthropologic museums almost equally with those growing out of esthetic activities, and probably a fourth part of the current literature of anthropology is devoted to them and the activities by which they are produced. Together they form the object-matter of a large and rich science commonly called *Technology*.

It is to be noted that the greater part of the material investigated by the archæologist pertains also to the fields of Esthetology and Technology, though these are far broader in that they extend not only to a greater variety of activital products, but to the activities themselves. It may also be noted that both esthetics and industries, originating as they do in vital processes, are primarily individual, though they become collective partly through combination with higher activities; while the higher activities of the series are primarily collective. It is noteworthy, too, that the two lower classes of essentially human activities rest on a material basis and are represented primarily by material devices, while the

of science in general. Several investigators have contributed to it; perhaps the earliest, one of the most voluminous, and certainly the most original, of these contributors is J. W. Powell, whose preliminary writings have appeared in a large number of addresses, official reports and minor papers, though his final conclusions are not yet published.

activities of higher planes rise above the material in their essential character and are only incidentally represented by material devices.

3. The activities of the third class are connected with collective relations; and, since they grow out of consanguinity or family relation, they may be said to have a biotic germ. In general, the products of these activities originate as customs which grade into regulations and later into laws, and are perpetuated in tribal, national and other institutions. The activities and their products are most intimately connected with, and indeed form the chief basis of, cultural progress. In the first culture stage, corresponding to what is commonly called savagery, the collective or social relation is based on kinship traced in the maternal line; in the stage commonly called barbarism, social relation rests on kinship traced through the paternal line, these stages forming tribal society. In the third stage the social organization passes from patriarchy, through feudalism, or an equivalent intermediate condition not yet formulated, to that stage of individual property-right in lands and goods which is commonly called civilization; and men are now passing into the stage characterized by intellectual property-right which is commonly called enlightenment, the organization in the last two stages being essentially non-consanguineal and constituting what is sometimes called national society. The several activities and activital products belonging to this class form the object-matter of a fecund science commonly called *Sociology*, though the day of final agreement concerning the definition of the term is not yet.

4. In some measure the activities of the fourth class are an outgrowth of those of the third, since, although essentially superorganic, they may be regarded as a means of establishing and maintaining relation; they comprise expression, pantomimic, oral and graphic. Like the other activities, they arise and expand in a certain order; beginning with what is somewhat incongruously called gesture-speech and with rudely articulate language, they mature in oratory and literature; and it is significant that the lines of development, so far as ascertained, run counter to those of biotic evolution in that they are almost wholly convergent instead of divergent; so that these activities pertain, in every essential respect, to the superorganic realm of humanity. The principal activities are speech and writing; the tangible products are legend and literature; but the rich and ever-growing content of these products is knowledge. The activities of expression and their products are commonly combined as the object-matter of another science frequently called *Philology*, though in this case, too, there is diversity in definition, and also in designation.

5. There remains a class of elusive and protean, yet immeasurably potent, activities which come so near the ego and are so hard to grasp and difficult to convey that it would seem almost hopeless to attempt to define them; they are the essentially intellectual activities which form the motive and burden of expression, and their products comprise beliefs, opinions, knowledge, wisdom and all other purely intellectual possessions. These activities also arise in a definite order, which is set forth incidentally in earlier paragraphs; and by most systematic thinkers they are considered to mature in science. The activities and their products are so obscure and so diverse that they have not been combined and named in the vernacular; yet they are by some students regarded as the object-matter of one of the broadest of the special sciences, *Sophiology*.*

So there are five classes of essentially human activities and activital products, each

*Sixteenth Annual Report of the Bureau of American Ethnology, 1897, page xviii.

so rich in phenomena and principles and so far distinct from all other classes of things as to constitute an adequate basis for a science; they are the fine arts, or esthetics, giving basis for Esthetology; industries, forming the object-matter of Technology; organizations or institutions, affording foundation for Sociology; language and literature with their science of Philology; and the great plasma of knowledge, forming the ill-defined but all-important object-matter of Sophiology. The five fields of research pertain primarily to Man and thus represent Anthropology; yet even casual survey of their extent and character renders it evident that they pertain not at all to the animal side of Man, but wholly to that side which intellectual Man alone possesses; they are five sciences of Humanity. Partly to distinguish them from the three distinct branches of knowledge concerning animal man, partly to fix their place in the body of knowledge, they have recently been combined under the term *Demonomy*;* and this system of organized knowledge concerning wholly human things may fitly be designated the greater Science of Humanity.

VIII.

As knowledge arises it is applied to the promotion of happiness and welfare; this has been true of unorganized and unconsciously organized knowledge throughout the history of mankind, and is especially true of definitely organized knowledge which thereby becomes applied science. Now knowledge concerning the human activities, even while unconscious or half conscious only, reacts upon and shapes the activities in such manner as constantly to increase their potency. Some of the ways in which the science of humanity stimulates and strengthens human activities are especially noteworthy.

1. While the great domain of Anthropology is divisible into an animal side comprising three broad sciences and a human side made up of five still broader fields of research, other classifications are possible, and indeed of special utility when directed toward the practical application of the science to every day affairs; for any assemblage of facts and relations may be classified in as many ways as there are purposes of classification. Experience shows that there is a peculiar advantage in classifying certain sciences by method of research rather than by the objects under investigation. Classified in this way, anthropology comprises: (1) demography, *i. e.*, the enumeration and description of men, activital products, etc.; (2) human geography (or anthropogeography), dealing with the geographic distribution of peoples and their artifacts; (3) political economy, which is concerned primarily with applied social forces and their products; (4) history, which deals with the rise and fall of peoples and nations; (5) philosophy, which scrutinizes materials and forces and sequences, and seeks the causes of growth and decadence among human things. This classification traverses the same domain as the more general one, and serves to bring out the same facts and relations in somewhat different light, *i. e.*, it is artificial rather than natural, technical rather than logical, subjective rather than objective, directive rather than creative; in brief, it pertains to applications rather than original research. For certain purposes it is desirable to combine the classifications and define special fields of inquiry by the coincidence between the two, as has recently been done happily by Giddings* and others; for the lines of thought represented in the two systems are strengthened by interaction; the one represents science, while the other may stand for statecraft or

* Fifteenth Annual Report of the Bureau of Ethnology, 1897, page xix.

* 'The Principles of Sociology,' 1896, page 49.

learning, and the two combine to advance mankind in knowledge and power.

2. At the outset the science of ethnology was closely affiliated with zoology, representing indeed little more than the concentration of biologic inquiry on a single order of animate organisms; but with the recognition of human activities this science was raised to a new plane. The applications of demonomy in the classification of peoples and races are many and sweeping; already the natives of the western hemisphere are classified primarily by language and incidentally by other demotic features rather than by any or all biotic characters; already the great stages in human progress from savagery to enlightenment are seriated in terms of social organization in lieu of those of the bodily features with which the biologist is wont to deal; already the present-day ethnologist gives first thought to the arts, industries, institutions, languages and ideas of the races rather than to any or all of those individual features comprised in stature and form and color; already, indeed, the recognition of human activities and the course of human development has served to revolutionize the science of races no less completely than the older sciences were revolutionized by recognition of force and sequence; and just as the New Astronomy, the New Chemistry and the New Geology are distinguished, so it is meet to distinguish a New Ethnology as a science of artificially organized groups rather than of mere upright animals.

3. With the rise of knowledge concerning activities, it was perceived that the primary function and ultimate end of devices have always been to extend and increase human power, to enable man to control plants and subjugate animals, and to evade or utilize sun and storm, *i. e.*, to make conquest of lower nature; accordingly it was recognized that, while the human characters reflect environment measurably, as the purely biotic characters do fully, it is the essential tendency and character of man to control, rather than to be controlled by, his environment. This human power did not spring into being full-fledged—indeed, science knows no Minervan birth—but grew up slowly through the exercise and gradual strengthening of volition and the evolution of design; so primitive peoples are partially controlled by their environment, while the control diminishes with successive culture stages up to that of enlightened man who dominates by multifarious devices nearly every physical force. Examination of the successive stages in emancipation from environment brings to light many significant relations; thus it is found that when two or more primitive peoples of similar culture are subjected to similar conditions of environment their minds respond in similar ways, so that similar devices are discovered or invented; and recognition of this law of human progress has served to correct some of the most persistent misapprehensions by which anthropology, like all other sciences in their infancy, has been burdened. At the same time the recognition of progressively increasing conquest over the inorganic, and the organic merely, has served to define and dignify man's estate at the head of all nature.

4. Although certain human characters and characteristics were already under investigation, it can hardly be said that mankind in general came into the domain of scientific inquiry until the Darwinian doctrine of evolution was accepted; accordingly, anthropologists at first regarded Man as subject to the law of organic development through the survival of the fittest. Then came the recognition of activital development in contradistinction from organic development, and the pendulum of opinion swung back so far as the most modern anthropologists implicitly assumed the human

form—the form of the order Bimana, genus *Homo*, and species *sapiens*—to be fixed and final. It now appears that the pendulum swung too far; for a long series of highly significant yet but half appreciative observations indicate that, just as the human mind dominates the materials and forces of lower nature, so may it measurably control and fashion the organism in which it is embodied; already hygiene and gymnastics have improved unnumbered physiques and lengthened the days of thousands; already leading educational institutions maintain physical departments in which they undertake so to shape and strengthen the limbs and lungs and even the heart and bone of the matriculate that he may be graduated sound in body as strong in mind; yet these indications would seem only to point the way of progress, and promise still better things in human development as later generations rise.

5. The most elusive attributes of humanity are those manifested in conduct and feeling and thought; yet, paradoxically, it was these obscure products of intellectual activity that men first sought to guide and control, for in every generation, in each stage of culture from the lowest savagery to the highest enlightenment, parents have essayed to train their children, while first the tribal leaders and later the sages and statesmen have semi-consciously or in full consciousness striven ceaselessly to shape the minds of the masses. So education, or the voluntary control of individual mentality for the common good, has affected profoundly the entire course of human development, and has served ever to widen the chasm separating man from the beasts. In the earlier stages of culture, as indicated by the customs of savages still living, education was limited to the lowly esthetic and industrial activity of the prime; for the primitive thinker ascribes motive, complex feeling, and all but the simplest actions to ill-conceived extraneous potencies against which it were bootless to strive. In higher savagery and in barbarism the sphere of education extended to those features of conduct involved in the maintenance of tribal relations, and was effected partly by means of habitual appeal to the extraneous potencies which were gradually crystallized in mythic systems themselves arising in a certain order determined partly by educational practice; for in much of savagery and in all of barbarism the sources of sentiment and motive are sought outside the individual and largely beyond the realm of the real. With the birth of civilization education extended to feeling and thought, partly through appeal to ideal potencies, and there was a tendency to exalt the esthetic and neglect the industrial; and certain educational systems rose so high into the supernal or passed so far into the metaphysical as to lose sight alike of individual conduct and the sources of real knowledge. In modern enlightenment—especially in America—the methods and purposes of training are shaped by science, and, despite the struggle of the scholastics, education is becoming revolutionized. With the recognition of an actual universe knowable through sense and reason, training becomes definite in plan and useful in purpose; with the recognition of cerebral function and of the influence of exercise in developing the brain, the scientific psychologists of the present decade have gone far in erecting a new platform for pedagogy; and with the recognition of the relations among the activities and the activital products of man, the normal course of intellectual development would appear to have been made clear; for it seems manifest that just as observation begins with the simple and proceeds toward the complex, and just as activity begins with the spontaneous and passes into the volitional, so individual and collective mentality must arise in simple and perhaps

spontaneous action, to grow, through habit, into sentiment, and to mature, through unconscious or conscious thought, in definite motive. It is heterodox, perhaps in more senses than one, to affirm that motive—the noblest character of humanity—buds in spontaneous action, blossoms in subconscious habit, and attains fruition in the highest intellectual activity, whether unconscious or conscious, of which the individual or group is capable; certainly the affirmation represents complete inversion of a notion prevalent in savagery, dominant in barbarism, and gradually weakening through civilization; yet it is sustained by all that is known of the processes of acquiring knowledge, by the history of the growth of knowledge in general, and, indeed, by nearly all applied statecraft and most applied priestcraft throughout human history. The recognition of the genesis and antecedents of motive must afford a vantage point for a clearer survey of the vast field of human emotion, affection, passion, aspiration, disposition; and, at the same time, it cannot fail to give a key-note for improved education—for the still more complete control of mind.

These are but a few of the many ways* in which the great science based on human activities tends to bring order out of that vast chaos of action and thought which has so long resisted analysis and synthesis—that last citadel of the unknown.

IX.

Hitherto Humanity has been the theme of poesy and romance rather than of sober science. All men have perceived that their kind possess attributes distinguishing them from the rocks and plants and beasts of lower nature, yet for the most part these attributes were either ignored or transfigured into a dazzling halo which defied analysis none the less by reason of its subjective character; even to-day and in the most enlightened circles of the most enlightened nations there are few willing to consider, and content to consider dispassionately, the purely human attributes; but to these few the chaos of industries and ideals, of emotions and passions, of conduct and motive, and of all other things human, falls into a simple order nearly as definite as the order recognized in each of the older sciences—the order of human activities and activital products.

Exact knowledge began with the remote and progressed toward the near; with every stage of progress it has been a power for the conquest of natural forces and conditions, has exalted intellectual mankind above all brainless or small-brained creatures, and has made continually for human welfare and happiness; and now, that the methods and purposes of science are extending to the human body and brain, it cannot be doubted that these, like all other material things, will be controlled and reconstructed for the good and the glory of intelligent Man. This is the end of the Science of Humanity.

W J McGEE.

* One of these is the control of society itself for the common good, as shown by Ward in his masterly memoir on 'Dynamic Sociology,' which it must suffice to mention merely.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION F.—ZOOLOGY.

The officers of the Section were as follows:

L. O. Howard, Washington, Vice-President; C. C. Nutting, Iowa City, Ia., Secretary; F. M. Webster, Councillor.

Sectional Committee: L. O. Howard, Vice-President, 1897; C. C. Nutting, Secretary, 1897; Theodore Gill, Vice-President, 1896; D. S. Kellicott, Secretary, 1896; Charles Sedgwick Minot, Henry F. Osborn, Wm. H. Ashmead.

Member of Nominating Committee: Wm. H. Ashmead.

Committee to Nominate Officers of Section: The Vice-President and Secretary and Charles Sedgwick Minot, Theodore Gill, F. M. Webster.

The scientific papers presented were as follows:

The Spread of Land Species by the Agency of Man with special Reference to Insects. Address of Vice-President Dr. L. O. Howard. Printed in Science, Sept. 10th.

(1) *On the Relationships of the Nematognaths.* By Theodore Gill, M.D., LL.D., Professor of Zoology, Columbian University, Washington, D. C.

The Nematognaths have been considered by most ichthyologists to be most nearly related to the Ganoids or even associated with them in the same order. Their entire structure, however, indicates that they are most nearly related to the Plectospondyls, and they may even associate in the same superorder for which the name Ostariophysi of Sagenmehl may be adopted.

(1) *On a Collection of Cephalopoda from the Albatross Expedition.* By Wm. E. Hoyle, Owens College, Manchester, England.

(6) *On the Sarcostyles of the Plumularidæ.* By Professor C. C. Nutting, A.M., Iowa City, Iowa.

The morphology of the Sarcostyles has been investigated by various writers from the middle of the century to the present. They are composed of ectoderm, endoderm and, according to most writers, a solid axial rod.

A body cavity was described by one of the earliest writers and redescribed by the present writer. The Sarcostyles are undoubtedly degraded 'persons' of the hydroid colony.

The function of these structures is not well understood. It appears to be partly defensive, partly prehensile and partly offensive. The function of scavengers and digestive organs has also been ascribed to them.

(8) *Notes on the Development of Drasteria erechtea.* By Professor F. M. Webster, Wooster, Ohio.

The paper gives the results obtained from rearing larvæ from the eggs to adults, and shows the individual variation of each, both in habit and appearance, the latter being the object of the studies.

(9) *Brood XVI. of Cicada septendecim in Ohio.* By Professor F. M. Webster, Wooster, Ohio.

The paper deals with the occurrence of Brood XVI. of *Cicada septendecim* in Ohio, in 1897. The area over which it has been observed is indicated; the influence of natural enemies is discussed and the probabilities of its becoming extinguished are explained.

(10) *Notes on the Embryology of the Pig.* By Dr. Charles Sedgwick Minot, Readville, Mass.

(1) *The Hypophysis.* There is a true infundibular gland, which is homologous with the saccus vasculosus of Teleosts, and is identical in form and connections with the embryonic saccus. The duct of the gland becomes a solid stalk.

There is also a true hypophysis, which develops a vestibule and gland-tubes homologous with the same parts throughout the vertebrate series.

(2) *The Cardinal Vein.* It is a striking peculiarity of transverse sections of pig-embryos that in the region of the Wolffian body no distinct vein appears, corresponding to the cardinal vein, usually found on the dorsal side of the Wolffian body. This is due to the fact that in the pig the cardinal vein, after entering the cephalic end of Wolffian body, breaks into a multiplied sinus, in which are lodged the Wolffian tubules. Another peculiarity of the cardinal vein is that it does join the jugular to

form the transverse Ductus buvieri, but joins instead the great hepatic vein (Ductus arantii) not far from the heart.

(3) *Allantoic Villi.* The stalk of the Allantois begins to form on its cephalad side within the abdomen a series of lobulated outgrowths, which gradually increase until they occupy a relatively considerable space in the abdomen. These villi consist of a cuboidal mesothelium covering a mass of matricial or ground substance, in which are scattered a few cells of mesenchymal character. The villi are beginning their development in embryos of 14.0–17.0 mm., and are already reduced in embryo of 24.0 mm. The author has no surmise to offer as to their function. Nothing similar to them is known in other mammals.

(11) *Harvard Embryological Collection.* By DR. CHARLES SEDGWICK MINOT, Readville, Mass.

The collection consists mainly of series of sections of vertebrate embryos. It is expected ultimately to have representatives of several divisions of the Mammalia, and of the principle types of non-Mammalian vertebrates.

The work of forming the collection is going forward with the following forms:

Man	Necturus
Dog	Amia
Pig	Amiurus
Rabbit	Batrachus
Chick	Acanthias
Lacerta	Torpedo
Frog	Petromyzon
Amblystoma	Amphyoxus

The plan is to select for each form a carefully graduated series of stages, and to make of each stage three complete series of sections in three planes, the transverse, the sagittal and the frontal, or if the embryo is curved or twisted the three planes are chosen at right angles to one another. A drawing of each stage is made. A double catalogue is kept; the first, in book form, is the entry-catalogue, and records all details of preservation, cutting, staining and mounting. The series of sections are numbered according to their order of entry. The second catalogue is on cards, which are arranged first according to species, second under each species according to stage. Every series of sections has a separate entry number and a separate card. Every section is counted and the sections of every series numbered. At the present time there are about one hundred series completed.

The collection is intended primarily for investigators, and is open to all competent investigators working in the Embryological Laboratory. It is hoped that it will increase during years to come, in size and still more in usefulness. So far as known to the writer, it is the first collection of the kind to be started.

(12) *Organic Selection.* By PROFESSOR H. F. OSBORN, Columbia University, and PROFESSOR E. B. POULTON, Oxford University. Duplicate title (see No. 25).

(14) *Characters for Distinguishing the North American Species of Ceresa.* By WM. H. ASHMEAD, United States National Museum, Washington, D. C.

An explanation of the application of recently discovered morphological characters to the classification of the Homopterous genus *Ceresa.* The author points out the fact that many of the genera in the Membracidæ are merely dimorphic forms of other genera.

(23) *Reconstruction of Phenacodus primævus, the most Primitive Ungulate.* By PROFESSOR HENRY F. OSBORN, Columbia University, New York.

This paper is accompanied by the remounted skeleton of Phenacodus and a wax model executed by Charles Knight. As originally mounted in Professor Cope's laboratory, the famous skeleton of *Phenacodus pri-*

mævus conveyed a very imperfect impression of its actual form and proportions. Several serious errors were committed by the restorer, the most important of which was the implanting of two of the cervical vertebræ in the tail. The author, therefore, considered it advisable to completely remount the animal, and this has been done by Mr. Adam Herman and Mr. Martin, of the American Museum, at an expenditure of five months' time.

The animal is placed as nearly as possible in a natural position. It shows that the feet were not plantigrade, or soled upon the ground, but digitigrade, as in the Tapir. The body is characterized by the great convexity of the back, characteristic of the carnivore and of all early ungulates. A further carnivorous feature is the great development of the hind quarters and of the tail. The disproportion between the hind and the forequarters is heightened by the extremely small size of the head, containing a brain which was about the size of that of the opossum, which has been fully described by Cope.

(24) *Homologies and Nomenclature of the Elements of the Molar Teeth.* By Professor Henry F. Osborn, Columbia University, New York.

After a brief review of the tritubercular theory of Cope, the writer spoke of his hypothesis advanced at the American Association meeting in 1891, that the multitubercular teeth of the Multituberculata and Monotremata were also of tritubercular origin. This hypothesis seems now to be confirmed by the teeth of Gomphodontia, especially of the genus *Diadermodon*, by Professor Seeley in the Narvo Beds of South Africa, of Permian age.

The various Gomphodonts in these beds present molar teeth of more or less regular tritubercular pattern. Related to them in skull structure is Tritylodon—a typical multituberculate. This indicates that from the trituberculate Gomphodonts Tritylodon and other multituberculates may have taken their origin. The paper was discussed by Professor Minot and Dr. Gill.

(25) *Modification and Variation and the Limits of Organic Selection.* By Professor Henry F. Osborn, Columbia University, New York, and Professor Edward B. Poulton, Oxford University, England.

[An account of these papers will be published in a subsequent issue of Science.]

(26) *Geographical Distribution of the Golden Warblers.* By Harry G. Oberholser, Biological Survey, United States Department of Agriculture, Washington, D. C.

The so-called Golden Warblers form a group of some twenty-five species and subspecies in the genus Dendroica, and are distributed over almost all the Nearctic region, together with the Antillian, Colombian and Central American subregions of the Neotropical. The greatest differentiation of forms occurs in the West Indies, where the distribution of many of the species is somewhat anomalous.

(27) *Modern and Older Theories of Mimicry Illustrated by Butterflies of the Genus Hypolininas.* By Professor Edward B. Poulton, Oxford University, England. [To be published in Science in abstract.]

Wm. H. Ashmead,
Press Secretary.

FIELD WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY.

Most of the reports from the field parties of the United States Coast and Geodetic Survey are now in, and it is possible to summarize the work for the fiscal year ending June 30, 1897.

The operations have been, as usual, widely distributed, and cover localities on the Atlantic, Gulf and Pacific coasts, including Alaska. Much work has also been

done in the interior. Thirty land and ten parties operating on the sea were on duty during the year. The results of the labors of the land parties were as follows:

The new topographical survey of the shores of Buzzard's Bay, Massachusetts, finished.

San Francisco Harbor and Bay, nearly finished.

The Los Angeles base line in California, connected with the existing triangulation and a scheme developed by means of which a grand scheme of trigonometrical figures may be carried northward. This base, although measured years ago, had never been adequately transferred to the triangulation.

The chronometric determination of the longitude of Unalaska and Kadiak Islands, on the Aleutian Peninsula, Alaska.

The determination of the magnetic elements (declination, dip, and horizontal intensity) in nine Western States, principally in California, Montana, North and South Dakota and Nebraska.

Precise levelling in Kansas and Mississippi.

Trigonometrical work in Maryland and Delaware, completing the last direct triangulation on the Transcontinental Arc from Cape May to San Francisco.

Measure of a base at Salt Lake City with the new Duplex base apparatus.

Topography on Long Island.

Base measures in Kansas.

Triangulation at the mouth of Chesapeake Bay.

Topography and triangulation at the mouth of the Patapsco River, and on the Chester River, Maryland.

Reconnoissance in Nebraska.

Telegraphic longitude in Massachusetts, New York, Washington and Canada.

Hydrography, topography and triangulation of Lake Pontchartrain, Louisiana.

Traverse line across the Peninsula of Florida from Fernandina to Cedar Keys to connect the Gulf and Atlantic Coast triangulation.

Continuation and completion of the oblique arc along the Appalachian Chain from Maine to Mobile.

New survey of the Pribilof Islands, Bering Sea.

Connection of longitude station at Montreal with primary triangulation in New England.

Other unimportant operations were also carried on, the above being a general summary of the greater divisions of the work.

The work of the parties operating from vessels was:

Hydrographic work on the New England coast and on the Chesapeake Bay.

Special surveys on the outer bar at Brunswick, Georgia, and Long Island Sound.

Examination of Savannah River Entrance and the mouth of Elizabeth River.

Survey of Lake Pontchartrain, Louisiana, and Brazos River, Texas.

General Hydrographic work in Alaska and in San Francisco Bay.

Special work has also been done in laying out speed trial courses for testing the battleships and torpedo boats of the navy; soundings for new positions of light vessels, current observations, etc., etc.

As will be seen, the greatest activity in the land parties has been displayed in the fields of Topography, Triangulation and Magnetism. The original scheme of primary telegraphic longitudes has now been completed and the definitive values of the standard longitudes of the United States have been deduced.

The principal work of the sea parties has been on the coast of New England, in Alaska and in San Francisco Bay.

The operations during the fiscal year just closed have been productive of important results from both commercial and strategic standpoints. The completion of the survey of Buzzard's Bay, the beginning of the work near Baltimore and the rapid progress made at San Francisco are all in the interest of national defense, while the accurate determination of the longitude of Unalaska and Kadiak Islands furnishes a check to the reckoning of all vessels bound from Sitka to the mouth of the Yukon. The new speed trial courses are valuable auxiliaries to the navy, and examinations for new positions of light vessels are necessary alike to the naval and merchant marine.

The aid given to the Seal Fishery Commissioners in the way of transportation, etc., to the Guadaloupe Islands, and the cooperation with the engineer department of the army on the Brazos River, Texas, must be reckoned as not the least important incidents of the work from a commercial and

practical point of view. The progress made in all branches of the work, although comparing favorably with the operations of previous years, has not been as apparent as usual on account of many pieces of patch work made necessary by the rapid strides in the past. The work across the peninsula of Florida from Fernandina to Cedar Keys was broken off at the beginning of the Civil War and remained untouched until last winter. It will be completed during the coming season. The Transcontinental Arc begun in 1871 has just been completed by the direct chain of triangulation from Washington to Cape May, thus cutting off the older and less reliable work by way of Delaware Bay. This work, of the highest importance in international geodesy, together with the completion of the oblique arc from Maine to Mobile, already mentioned, marks an era in American geodesy and contributes new and valuable information as to the size and shape of the earth.

P.

CURRENT NOTES ON PHYSIOGRAPHY.

THREE DRIFT SHEETS OF IOWA.

The work of Calvin on Iowan drift is continued by Bain (Iowa Geol. Survey, VI., 1896, 429–476), whose report is of much geographical interest. The Kansan drift forms the surface of rather more than the southern half of the State; it is deeply weathered, the granite boulders being badly rotted and the limestone leached out; the surface is well carved by streams and holds no lakes. The Iowan drift occupies somewhat less than the northern half of the State; it is also well dissected, but less completely than the Kansan, and sloughs remain here and there on its surface. No moraine is found along its margin; but extensive loess deposits are spread forward from it over the dissected surface of the Kansan sheet. The Wisconsin drift is well developed in a strong lobe that invades the State to a little south of its center, and thus overlaps both the older sheets. Its surface is much less dissected by valleys, and many lakes remain upon it. Its border is marked by a strong moraine, from which extensive gravel trains are prolonged down the outer valleys. The diversity of the glacial period and the considerable value of inter-glacial epochs thus find much support from the Iowan geologists.

A special discussion of erosion curves accompanies the account of the Kansan drift topography; and it is pointed out that many of the rivers of to-day, although occupying valleys carved in the drift, nevertheless follow preglacial or interglacial courses, and are therefore to be called resurrected, following McGee's use of this term.

MOUNT ST. HELENS.

Lieut. C. P. Elliott, U. S. A., gives an interesting account of Mount St. Helens (Nat. Geogr. Mag., VIII., 1897, 226–230), from which many items appropriate to its class may be gathered. The mountain stands west of the Cascade range divide, its truncated cone reaching a height of 8,608 feet. Its scopes have been dissected by ravine streams and repaired by lava streams, the latter often interfering with the escape of the former and producing lakes and swamps. The ravines have the radial course usual on dissected volcanoes. The flows of lava and volcanic sand descend from near the mountain summit, running around hills as a river passes islands, and 'filling up the country' in their course. Spirit lake, five miles northeast of the summit, occupies a valley dammed by sand, ashes and pumice, which are there very plentiful. A flow that descends five miles to the southwest of the summit first nearly fills in the depression toward Green buttes; then passing around the buttes, the lava unites and fills in between Goat mountain and a ridge northeast

of it, forming a large swamp; further on it obstructs a valley on the south, forming Lake Merrill, and finally Kalama river falls over the end of the flow. Many large springs emerge from beneath the lava flows.

MAARE OF THE EIFEL.

HALBFASS presents the results of soundings and temperature observations in the eight Eifel maare (Petermann's Mitt., XLIII., 1897, 149–153; with more detail in Verh. Naturh. Vereins, Bonn, 1897). A ninth maar (Wanzenboden) is only two or three m. deep, and in part thickly occupied with reeds; the Hinkelsmaar and many other basins are now converted into dry meadows. Those which still hold water deepen from margin to center; at first gradually, then more rapidly with slopes of 20–30°, and again gently near the center. Only the Laacher See is large enough to have a well defined flat central floor. The Pulver maar is the deepest (74 m.) of all German lakes outside of the Alps. The shore lines approach a circular outline, but the Meerfelder maar is like a half moon, occupying only half of its circular basin. Much statistical statement of fact with arithmetical comparison of the different maare is given. The life-history of the lakes is not directly considered.

THE EASTERN ARCTIC SEA.

SUPAN gives a review of Nansen's polar expedition, from which the following notes on the eastern Arctic sea (the northern part of the 'eastern hemisphere') are taken (Petermann's Mitt., VII., 1897, 158–163). Sheets of ice occupy much of the surface, continually drifted by currents and winds; now torn apart and opening water channels, now pressed together and forming walls and ridges. The latter reach heights of nine m., and offer the greatest obstacles to sled travelling. The remnants of former ridges drift about in berg-like masses with steep walls. The drift ice here is contrasted with the much thicker pack ice west of Greenland. The winter snow began melting in June, and the firm drift ice was not revealed till the end of summer. Its color is then a dirty brown, caused chiefly by mineral dust. Fresh water pools are formed on the ice surface, surprisingly rich in microscopic organisms. The ice increased in thickness slowly through the winter to June, varied until August, and decreased to early winter. Thickening in summer is ascribed to freezing underneath of fresh water supplied by melting snow above. In early spring the ice was coldest, from —16° to —30°C. In summer it approached the melting point, and then became plastic, so that crushing took place without sound; bending frequently replaced breaking.

The discovery of the great depth of the Arctic, 3000–3900 met., where traversed by the Fram, is regarded as the most important geographical result of the expedition. Polar lands are, therefore, not to be expected. A sample of serial temperature soundings gives a surface layer 200 m. deep at —1°C.; a second layer, 660 m. thick, with mean temperature of +0°.22 C., and about 3000 m. of deep water with mean temperature of —0°.57 C. The surface layer has least salt, and the intermediate layer most. The latter is supplied from the North Atlantic, dipping beneath the Arctic surface layer because its density is determined by salinity rather than by temperature.

W. M. DAVIS.

HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

ARREST OF DEVELOPMENT IN HUMAN GROUPS.

ON this subject Professor Schrader has a curious article in the *Revue Mensuelle* of the Paris School of Anthropology. His conclusion is that the failure to advance or the actual retrogression of peoples and societies is a question of lack of adaptation to environment. This is not new; indeed, it is

quite old. His novel proposition is that, given a better environment, the most inferior race may become superior to all others. "That which we are to-day, others may be to-morrow." He also claims that a race long resident in a given *Milieu* becomes best suited to it, and, granted equal facilities, is sure to surpass all other races there. He quotes the native population of Mexico in illustration. "Conquered by Cortes, beaten into the dust by brutal European rule, it has seized the arms of its conquerors, and now is rising in its might above its ancient invaders. "Is it an illusion," he asks, "that reveals to us in the physiognomy of the Yankee the hard, bony face of the Red Skin?"

PRINCIPLES OF THE STUDY OF MYTHOLOGY.

In a recent number of the monthly journal *Nord und Sud*, Dr. Thomas Achelis has a suggestive article on the relations of mythology to ethnography. He advocates and illustrates the principle now constantly gaining ground among advanced anthropologists, that if we learn accurately the daily life of primitive peoples, understand the impressions they receive from their environment and the mental impulses they gain from language and the interchange of ideas, then psychology is prepared to explain their religious perceptions according to definite and fixed principles. Similarities or identities between remote tribes will no more call for the theory of unity of source than the mere similarity of the sound of words would justify the etymologist in adopting the same theory for its explanation.

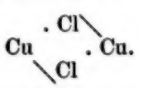
In all of his writings Dr. Achelis has pursued this same line of thought, and, although this has not recommended him to those of his reviewers who adhere to a more antiquated philosophy, there can be no question but his is the 'party of the future.'

D. G. Brinton.

University of Pennsylvania.

NOTES ON INORGANIC CHEMISTRY.

The seventh article of the series by Alfred Werner in the *Zeitschrift für anorganische Chemie*, on the constitution of inorganic compounds, describes molecular weight determinations of a large number of salts in organic solvents, such as piperidin, pyridin, methyl sulfid, etc. In the case of many salts regarding which there has been considerable doubt, the results were in accord with the monomolecular formula, as $AlCl_3$, $FeCl_3$, $FeCl_2$; also $CoCl_2$, $CoBr_2$. Tin (stannous) and lead salts were also found to be monomolecular. Cuprous salts were in general normal (CuCl, CuI, etc.), but showed considerable tendency to polymerize by doubling. Cuprous cyanid appeared only in dimolecular form, $Cu_2(CN)_2$. The silver halogen salts showed a strong tendency to polymerization, the iodid having a molecular weight corresponding to $(AgI)_2$, while the chlorid (and bromid) were between $(AgCl)_2$ and $(AgCl)_3$. Silver nitrate, however, had the normal formula $AgNO_3$. Professor Werner is of the opinion that in the polymerized molecule the metal atoms are not united together, but that the union is between metal and non-metal, as



It would seem possible, however, that the union might subsist through the medium of the non-metallic atoms, which would account for the greater tendency to polymerization on the part of the cyanids.

Boric acid has a quite extended use as a food preservative, but the data as to its effect on health are very meagre. R. A. Cripps, in the *Analyst* for July, recounts a series of experiments on the action of boric acid on the digestive ferments. His results are the following: With malt-extract in presence of 0.01% to 1% boric acid, starch was dissolved completely in 12 minutes, not

completely in 10 minutes. With saliva, starch was dissolved in the presence of 1% or less boric acid in from 8.5 to 11.5 minutes; with no boric acid 11.5 minutes was required. With pepsin, the digestion of egg albumen was not retarded in the presence of 1% boric acid. With zymin, milk albumen with 1% boric acid was completely peptonized in 2½ hours. With Blumenthal's chymosin, a far larger amount of boric acid than was necessary for preservation of food did not affect the fermenting action unfavorably. While boric acid thus does not retard digestion, its physiological action still remains to be finally settled.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

THE 'ENCHANTED MESA' OF NEW MEXICO.

A SURVEY has just been made of the 'Enchanted Mesa,' or Mesa Encantada, of New Mexico, by a party sent out by the Bureau of American Ethnology.

This mesa was brought into prominence several years ago through the work of Bandelier, who ascertained that the neighboring Acoma Indians have a tradition that their ancestors formerly occupied the summit, but abandoned it, together with a part of the tribe, in consequence of the destruction of the pathway leading up one of its precipitous sides; the catastrophe, which was doubtless due to a cloudburst, being ascribed to supernatural agency. The same tradition was subsequently obtained by C. F. Lummis, a well-known student of the Southwestern Indians, and also (with some confirmatory evidence) by F. W. Hodge, of the ethnologic bureau. The traditional catastrophe was so magnified by repetition and so enveloped in mystery that the Indians, and after them the white settlers, had come to regard the mesa as inaccessible.

Two years ago Mr. Hodge, then studying the Acoma Indians, planned to visit the summit in order to seek for traces of the alleged occupancy in prehistoric times; but he was deterred by regard for the sentiments of the Indians, who held the eminence sacred. During the present season, Professor William Libbey, of Princeton University, after elaborate preparations, ascended the mesa, without finding (so far as the accounts published in the newspapers indicate) evidence of occupancy. Reports of this failure duly reached the neighboring Indians; they were annoyed by the suggested impeachment of their tradition, and were thereby the more easily induced to permit the ethnologic party to visit their holy place. So, on September 3d, Mr. Hodge, accompanied by Major George H. Pradt, of Laguna, New Mexico, a U. S. Deputy Surveyor; Mr. A. C. Vroman, a photogropher of Pasadena, California; Mr. H. C. Hayt, of Chicago, and two Laguna Indians, proceeded from the Indian pueblo of Acoma to the foot of the mesa, three miles distant, where they were joined by three Acoma Indians. After measuring the eminence by triangulation (the mean of two determinations is 431 feet above the plain on the west), the party at once ascended along the ancient route, and encamped on the summit for the night. During the afternoon and the next day Mr. Hodge examined the ground critically, while Major Pradt made a survey of the mesa, and Mr. Vroman secured a number of photographs. Several potsherds, two stone axes (broken), a fragment of a shell bracelet and a stone arrowpoint were the chief evidences of former occupancy found on the narrow storm-swept crest; but abundant potsherds, etc., were found in the talus swept down from the summit. All vestiges of the ancient trail ascending the talus, and continued thence to the summit by hand and foot holes in the solid rock, have been obliterated; but some traces of the holes remain. This verification of an Indian tradition notable for inherent evidence of accuracy is peculiarly gratifying to students of anthropology.

Except for the easily-removed opposition of the Acoma Indians, no difficulty was found in ascending the mesa, save for a space of a few feet at the top of the cleft; this was easily crossed on a light extension ladder carried to meet emergencies, and might have been passed with the aid of a geologic hammer to cut a few hand-holes in the steepest part of the rock.

W J M

GENERAL.

We record with much regret the death of Mr. Theodore Lyman, the only honorary member of the National Academy of Sciences, formerly member of Congress and a distinguished officer in the army during the Civil War. Colonel Lyman was born in 1833 and died on the night of September 9th, at his summer home, at Nahant, Mass. He studied under Louis Agassiz, whose daughter he married. Colonel Lyman was a zoologist and geologist of distinction. He was the representative of a class more common in Great Britain than in the United States—a man of wealth, public spirit and wide culture, who contributed both directly and indirectly to the advancement of education, science and civilization.

The membership of the National Academy of Science is now eighty-three. The deaths and elections to the Academy during the last six years have been as follows:

Deaths.	*Elections.*
1891.	
Julius E. Hilgard,	None.
John Le Conte,	
Joseph Leidy,	
Miers F. Longstreth.	
1892.	
T. Sterry Hunt,	Carl Barus,
Joseph Lovering,	S. F. Emmons,
J. S. Newberry,	M. Carey Lea.
Lewis M. Rutherfurd,	
William P. Trowbridge,	
Sereno Watson.	
1893.	
W. H. C. Bartlett,	None.
F. A. Genth.	
1894.	
Charles E. Brown-Sequard,	None.
Josiah P. Cooke.	
1895.	
James D. Dana,	W. L. Elkin,
John Newton,	C. S. Sargent,
James E. Oliver.	W. H. Welch,
	C. O. Whitman.
1896.	
Thomas L. Casey,	C. D. Walcott,
G. Brown Goode,	R. S. Woodward.
Benjamin A. Gould,	
H. A. Newton.	
1897.	
E. D. Cope,	E. W. Morley,
M. Carey Lea,	C. S. Minot,
A. M. Mayer,	W. H. Dall,
J. H. Trumbull,	F. A. Gooch.
F. A. Walker,	
Theodore Lyman.	

The original act incorporating the National Academy, in 1863, limited the number of ordinary members to fifty, but this restriction was removed in 1870. A wise conservatism has regarded one hundred members as a suitable limit, but there appears to be no reason why the membership should decrease while the scientific activity of the country increases. Fifteen new members of the Royal Society are elected annually.

The seventh annual directory of the Scientific Alliance of New York, for the year ending 1897, has been published by the Council. The number of members is 1,055, an increase of forty over last year. The membership of the several societies comprising the Alliance is as follows:

The New York Academy of Sciences, resident members and fellows,	284
Torrey Botanical Club, active members,	221
New York Microscopical Society, active members,	88
The Linnæan Society of New York, resident members,	109
The New York Mineralogical Club, total membership,	65
American Mathematical Society, local membership,	47
The New York Section of the American Chemical Society, active members,	282
The New York Entomological Society, active members,	48

About fifty members of the British Association from Great Britain, including Lord Kelvin, Lord Lister and Sir John Evans, have taken part in the extended excursion to the Pacific Coast following the Toronto meeting of the Association.

The item, circulated by the newspapers, to the effect that four Ohio men of science had been treated with scant courtesy at the meeting of the British Association, is entirely without foundation. The complaint comes from only one of the number, a collector of fossils and a manufacturer of casts of the same, who failed to secure an announcement, concerning his specimens, in the geological section. There was, of course, no international feeling involved in the matter, The other three, professors in Cleveland and Oberlin, whose names were used

without their knowledge, repudiate any responsibility for the complaint, and say that they experienced nothing but perfect courtesy while at the Toronto meeting. Indeed, the original report contains numerous errors, for which the original complainant himself does not wish to be held responsible.

FRANZ PULSZKY, formerly director of the National Hungarian Museum and superintendent of the public museums and libraries of Hungary and a writer on archæological subjects, has died, aged 82 years. He took an important part in the attempts to establish Hungarian independence, and visited America with Kossuth, being long under sentence of death for treason against Austria.

THE Hon. Charles D. Walcott, Director of the U. S. Geological Survey, left San Francisco on September 7th, for the Yosemite Valley, accompanied by Assistant F. B. Weeks. According to a dispatch to the New York *Evening Post* he proposes to make topographical maps, on a two-mile scale, of all the forest reserves in California, which, including recent additions, comprise no less than 6,647,000 acres. On these maps the distribution of forests will be pointed out, showing the commercial and the non-commercial timber, the agricultural lands included in the forest reserves, and all settlements, roads, houses and other improvements upon the national forest domain. Since leaving Washington on July 23d Mr. Walcott has inspected the forest reserves in Wyoming, Montana, Idaho, Washington and Oregon.

THE Jackson-Harmsworth expedition duly reached London on September 3d. The results of three winters spent in scientific work in Franz Josef Land will doubtless include valuable contributions not only to Arctic geography and meteorology, but also to geology, zoology and botany.

MR. WALTER WELLMAN, the journalist and Arctic explorer, has returned to New York after a visit to Norway for the purpose of making arrangements for his proposed Arctic expedition. According to statements in the daily papers, he proposes to sail from Bergen in a staunch steamship on June 13th of next year for Franz Josef Land. He expects to establish a supply station at Cape Flora and to reach Cape Fligely before the winter sets in. Then, in 1899, he intends to try to traverse on sleds the 550 miles to the Pole.

MR. A. W. GRABAU, of Boston, is continuing the field excursions for the study of natural history begun last year and made possible by the generosity of an anonymous donor. He met applicants for membership at the Museum of Natural History on September 11th and gave an account of the course in marine zoology which will take the class to the seashore near Boston. At two o'clock the party left for Beverly. Other excursions have been arranged as follows: September 15th, Revere Beach; September 18th, Nahant; September 22d, Marblehead; September 25th, Swampscott; September 29th, Bass Point.

THE New York *Evening Post* reports that the Chabot Observatory, of Oakland, Cal., has decided to send a special expedition to India to observe the total eclipse of the sun. It will be headed by astronomer Burckhalter, whose expenses will be paid by William Pearson, of San Francisco. Dr. George C. Pardee will provide a new lens for the use of the observers. The expedition is, of course, entirely distinct from that to be sent out by the Lick Observatory, the funds for which were provided by the late Mr. Crocker.

THE Prince of Monaco, in his steam yacht, the Princess Alice, is said to have completed a season's researches in the Azores.

IN view of the outbreak of yellow fever at Ocean Springs, the Surgeon-General has instructed Dr. Wasdin to investigate the disease in accordance with Dr. Sanarelli's methods and has forwarded him the necessary outfit.

THE daily papers report Dr. H. B. Guppy, an English naturalist, returned to Napoopee, Hawaii, on September 1st, after spending twenty-three days alone on the summit of Mauna Loa, at an elevation of 13,000 feet above sea level. He carefully explored the crater of the volcano and made collections of the fauna and flora.

AN Engineers' Club has been established in Chicago, the object of which is to be the advancement of engineering in its several branches, the professional improvement of its members,

and the encouragement of social intercourse among men of practical science. It is proposed to publish proceedings, to maintain a library and a collection of drawings and models.

A Natural Science Association was organized in Jersey on August 5th, with Dr. A. C. Goodfrey as the first President.

The French Society of Civil Engineers appointed some time since a committee to consider the propositions that have been made for the decimalization of time and angles. This committee has made its report adverse to the proposed reform but recommending the numbering of the hours of a day continuously up to twenty-four.

In connection with the Brussels Exposition there was held an International Congress of Commerce and Industries from September 7th to 11th.

The library at Massillon, Ohio, has recently received generous gifts. The residence of the late Mr. Nahum Russell, valued at $30,000, has been presented to the city by his daughters, and Mr. J. W. McClymonds has given an endowment fund of $20,000.

The British 'blue-book,' recently issued relating to the nature and extent of the trade of Australia and adjacent colonies, contains some interesting and useful information for American manufacturers. It appears that, in New Zealand, for example, Germany and Belgium, not Great Britain, send in the greater part of the supply of firearms. Glassware comes from Belgium; saws, almost exclusively, from the United States. Axes come exclusively from the United States, and carpenters' hammers from the same source mainly, though England still furnishes the heavier and ruder sorts, such as are used by blacksmiths and machinists. Germany and Belgium supply nails, and the former is gradually encroaching upon the market for machine tools, formerly controlled by England. All the agricultural machinery is furnished by the manufacturers of the United States, who produce the most remarkable combination of lightness and strength, and yet sell at lower prices than even Continental nations can yet attain. The reasons for Great Britain's 'temporary decline' are said to be: Conservatism, lack of versatilty and adaptability, disdain of methods successfully adopted by competing vendors, stringency in calling for payment and 'a general haughtiness in trading transactions.' As one of the London trade papers says: "When a wealthy London corporation builds and equips a London railroad with American plant it is time for English manufacturers to see themselves as others see them."

It is stated in *Machinery* that Acetylene is now in use in several of the Paris omnibuses. The generator weighs about 29 lb., and is carried under the front steps. Each load of carbide is about 0.71 lb., and produces about 3 cubic feet of gas, which is enough for 6½ hours, with a light of 16 candles. The pressure is regulated so as not to exceed 4 inches of water. The cost is less than that of petroleum. Electrical accumulators to do the same work weighed nearly 3 cwt., and did mischief, so that they were glad to give them up.

The *Philosophical Review*, edited by President Schurman and Professors J. E. Creighton and James Seth, of Cornell University, and published since its foundation by Ginn & Co., will next year be published by The Macmillan Company.

The Principles of Sociology, by Professor Franklin H. Giddings, of Columbia University, of which a third edition has recently been published by The Macmillan Company, has been translated into French and German, and a Spanish translation is announced for early publication.

Volume two of the *Maryland Geological Survey Reports*, which will contain a description of the building and decorative stones of the State, is well advanced and will be issued the coming winter.

President C. G. Wilson, of the New York Board of Health, has made a report showing the remarkable decrease in the death-rate of New York City since 1823. Figures for the first eight months for each of the last six years.

	Estimated Population.	Deaths, Jan. to Aug., inclusive.	Death rate.
1893.....	1,758,010	31,982	27.3
1894.....	1,809,353	29,397	24.4
1895.....	1,879,195	30,699	24.5
1896.....	1,934,077	30,307	23.5
1897.....	1,990,562	26,866	20.2

THE report of the committee of the British Council on Education on schools for the blind and deaf, for the past year, has been published as a Blue-book, signed by the Duke of Devonshire and Sir John Gorst, and is abstracted in the London *Times*. During the year ending August 31, 1896, the number of certified schools increased from 84 to 91. These schools provide accommodation for 1,476 blind children (268 day scholars and 1,208 boarders), and for 3,004 deaf children (1,699 day scholars and 1,305 boarders). The total grants paid for the year amounted to £15,629 12s. A general report by the Rev. T. W. Sharpe, Senior Chief Inspector, follows, covering the year ended March 31, 1897. He states that the year has been marked by steady progress, and pleads for higher payment of teachers, both for the blind and deaf. The hope is expressed that a recent return called for by the department will produce some result. This return requires each school authority to give the name of every blind and deaf child in its district between the ages of 5 and 16 and 7 and 16 respectively. The address of the parent or guardian and the provision made under the statute for the education of the child are also required. With regard to deaf children, Mr Sharpe states that the teaching on the oral system in some institutions is very imperfectly carried out, and that oral teaching is in danger of being discredited from the fact that, however excellent the school teaching may be, the continued practice of speech outside the schoolroom is either left to chance or so mixed with signs that it receives very little care.

UNIVERSITY AND EDUCATIONAL NEWS.

DR. ANDREWS has withdrawn his resignation from the presidency of Brown University.

WE should be glad to welcome a 'Cosmopolitan' reading circle or Correspondence School, even though its standard should be no higher than that of *The Cosmopolitan* magazine. But the projectors of the 'Cosmopolitan University' cannot make silver equal to gold by debasing a name. Fortunately, the performance is illegal in the State of New York. Section 33, Chapter 378, of the laws of the State reads as follows:

> No individual, association or corporation not holding university or college degree-conferring powers by special charter from the Legislature of the State or from the regents shall confer any degrees, or after January 1, 1893, shall transact business under or in any way assume the name university or college, till it shall have received from the regents under their seal written permission to use such name.

The minimum requirements for a degree-conferring institution have been carefully defined by the regents, and it is scarcely needful to state that these cannot be met by an annex to a magazine.

AN editorial in the last number of the *Educational Review* on the Brown University incident concludes with the moral: "What a comment this occurrence is on the project for a national university at Washington, that is still kept alive by earnest but, we believe, misguided men!" The article was written on the assumption that "Rhode Island and Providence will not support an educational institution in which an officer of prominence holds views antagonistic to their own on an economic question that is under present discussion." The frank and wise declaration of the corporation of Brown University for academic freedom, even under aggravating circumstances, shows that the *Educational Review* is needlessly pessimistic in its point of view. It would, indeed, be better to have a struggle for academic freedom in a national university and lose than not to have the university and the struggle. The effect on other universities and on the education of the people would be beneficial, and the defeat would be but temporary. Neither pedagogy nor politics is at present a science, and they only come within the scope of this JOURNAL in so far as they concern the advancement of science. But an affiliation of the national scientific institutions at Washington, with power to grant degrees for research, would be the basis for a university in which science and investigation would have the place now held at Oxford, *e. g.*, bythe classics and information. It is a scientific experiment that all men of science should advocate.

THE *Educational Review*, however, appears to

be also pessimistic regarding those whom it calls 'natural scientists,' for the editorial quoted above says: "Devotees of natural science are, as a rule, the most intolerant of all university teachers, especially toward differences of opinion within their own sphere." We have published a number of articles on scientific education, but none of these have betrayed a prejudice against the classics equal to that against modern scientific education shown recently by Professor Wilson, of Princeton; Professor Peck, of Columbia, and President Stryker, of Hamilton, nor equal to that against the classics in the recent program of President Andrews, himself formerly a teacher of classics.

While engaged in promulgation we may remark that President Stryker, who had much to say last winter in regard to 'debasing' the A. B. degree by granting it for scientific studies, has allowed Hamilton College to give the degree of Ph. D. *causa honoris*. This, we believe, is illegal in the State of New York.

The will of Charles T. Wilder, of Wellesley, Mass., gives more than $100,000 to charitable and educational institutions, including $10,000 each to Robert College at Constantinople, the Armenian School for Girls at Constantinople, the Colorado College at Colorado Springs, Whitman College at Walla Walla, Wash., and Charleston College, Northfield, Mass. In a codicil dated July 27, 1897, Mr. Wilder bequeathed $15,000 to the trustees of Amherst College for the purchase of land for an observatory. The residue of the estate, both real and personal, is left to the executors in trust to be distributed among charitable, educational and religious institutions.

There is offered this year at Amherst College a prize of $500 for the best prepared freshman in the classical division and a similar prize of $300 in the scientific division.

Three new associate professors have been appointed at Oberlin College, Charles Edward St. John, Ph.D. (Harvard), in physics and mathematics; Herbert Lyon Jones, M.S. (Denison), A.M. (Harvard), in Botany, and S. F. McLennan, A.B. (Toronto), and Ph.D. (Chicago), in psychology and pedagogy.

At Williams College, Mr. Edward V. Huntingdon (Harvard) has been appointed instructor in mathematics and Mr. Frank H. Williams, assistant in chemistry.

DISCUSSION AND CORRESPONDENCE.

AMPHIBIA OR BATRACHIA.

As Professor Wilder * has expressed the hope that the discussion on the proper name of the class variously known as Amphibia or Batrachia 'may continue until all doubts are removed,' I venture to add my contribution. Dr. Baur† has treated the history of the nomenclature in his usual thorough manner, but perhaps has not laid sufficient emphasis on one point (although fully recognizing it himself), which has influenced me more than any others and probably will appeal to Professor Wilder more than the others.

The principle of priority of nomenclature should guide us in the selection of names of large groups as well as those of genera and species, provided there is no counteracting element or objection. It is especially important to retain the names of Linnæus as much as possible.

Linnæus introduced into the system six classes—Mammalia, Aves, Amphibia, Pisces, Insecta and Vermes. These have all been generally retained by succeeding naturalists except Amphibia. While many have adopted Amphibia, however, still more, perhaps, have employed Batrachia. But there appears to be no good reason for this use of Batrachia at the expense of Amphibia.

Amphibia should be retained as a *class* name, as it was at first given *as such*, and the fact that the class as originally constituted contained diverse elements should weigh no more against the adoption than the analogous extensions in the case of *Insecta* and *Vermes* or innumerable genera. The name should be restricted to the typical subdivision of the primitive Amphibia.

The name Amphibia, doubtless, expresses the concept of Linnæus derived from his own observations of living animals, and he must have been most impressed with the metamorphosis of some which he mentions first among

* Science, August 20, 1897, p. 295.

† Science, July 30, 1897, pp. 170–174.

biological attributes of the class ('aliis metamorphosin subire'). But however this may be, the name was first limited to the forms undergoing metamorphosis by De Blainville, and there is no reason why that restriction should not be respected.

The name Batraciens, or Batrachia, was given as an *ordinal* name. It was not used as a class name till long after Amphibia had been duly restricted to the class still so called.

If the name Batrachia were usable at all it should only be as an ordinal designation, as Huxley has done. But it cannot be legitimately used as such, because many years before the name Salientia had been introduced by Laurenti for the same order, and most of the best herpetologists of the present time (Cope, Boulenger, et al.), have revived or accept the name for the order so designated.

The name Amphibia was first used as a class name by Linnæus for a group which was certainly very heterogeneous, inasmuch as it included not only the typical Amphibians and reptiles, but also the Marsipobranchs and Selachians, as well as certain true fishes (Lophius, Acipenser, etc.). The class was divested of the fish-like forms by the editor of the Systema Naturæ (Gmelin, 1788), and with these limits it was long retained.

The essential point in the case under consideration is that Linnæus first recognized a *class* intermediate between fishes and birds, whose *typical* representatives pass part of their life in water and part on land, and the apt name Amphibia was given to that class. (The name is eminently suggestive and expressive for the class as now limited.) Batrachia was given long afterwards both as an ordinal and class designation. (The name is quite inapt for many of the species.)

THEO. GILL.

SURVIVAL OF THE ART OF ILLUMINATING MANUSCRIPTS AMONG THE GERMANS IN EASTERN PENNSYLVANIA.

AMONG the interesting objects included in the collection of tools, utensils and paraphernalia, representing the life of the American pioneer, recently made for the Historical Society of Bucks County, Pennsylvania, two curious paint boxes, for a time defying explanation, have at last led to an interesting observation. By degrees, after a series of investigations, beginning on August 20th, I learned that these boxes had contained, in their wooden compartments, the paints and colored inks by which the masters of the German schools in upper Bucks County (discontinued about 1850), taught the art of *Fractur*, or illuminative handwriting done in colors for permanent preservation. The liquid colors mixed in whiskey were contained in the little glass bottles still occupying their pigeon holes in one of the boxes. Other bottles contained inks, and one the varnish, consisting of the gum of the cherry tree diluted in water. A long compartment held the brushes and quill pens.

With these implements the masters of *Fractur*, generally Mennonites (who sometimes instructed pupils in the art as an addition to the ordinary tuition of a schoolmaster), illuminated the title pages of numerous Mennonite manuscript song books still extant in the county, produced elaborate title pages for Bibles, name cards, marriage and death registers, and Scriptural texts. A striking example in the possession of Henry K. Gross, of Doylestown, is a transcription of the 18th verse of the 19th chapter of John with decorated letters and floriated capitals in red, green, brown, blue and black, set above a bar of music, and twelve lines of cursive manuscript, upon which are placed two birds in red, green and black. A pious admonition in red and black text edges transversely the left end, while the lower margin is filled with an alphabet in various text. The borders are floriated and plain red or blue.

Further examples are: A, Title page to Church song book (*Lieder Buch*, printed in Germantown, by Michael Villmeyer, in 1811), name Susanna Fretz upon heart, from which springs a tree with conventional tulips; deep beaded borderings, 1814, colors red, brown, yellow and black, red predominant. B, Title page to manuscript song book, name Susanna Fretz (spelled Fretzin for feminine) in red circle with date 1810; stalks with black leaves and conventional tulips to right and left; foliated border with red leaves on black and yellow ground. C, Title page to manuscript hymnbook; name,

Joseph Gross, illuminated letters, foliated capitals; date, April 20, 1830; double tulips in foliate on yellow ground. D, Title page to manuscript hymn book, name Sarah Wismer; foliated capitals, conventional flowers on heavy stalks; date 1827; colors red, yellow, brown and blue. E, Title page to ditto; name, Elizabeth Nesch (Neschin), with words Dieses Sing-Noten Buchlein Gehoret Mir; Sing Schuler In Der Bedminster Schule; Geschrieben September 6—ten im Jahr 1799, with three tulips and several colors. Other examples are within easy reach of the writer. And it has appeared evident that the art thus preserved by Mennonites in a remote part of Bucks County until about 1850, and represented by the old paint boxes in possession of the Historical Society, is a survival in America of the mediæval art of manuscript illumination. Much more remains to be said upon this subject which reveals the early relation of Germany to the United States in one of its most interesting aspects.

HENRY C. MERCER.

INDIAN HOUSE, August 30, 1897.

REMARKABLE HAILSTONES.

ABOUT 5 o'clock in the afternoon of August 10th I was at Manassas depot, in Prince William County, Va., near the famous battlefield, waiting for a train. There was some pretty severe thunder and lightning for a half hour or so, and then came a heavy shower of rain, during which there was the most remarkable fall of hail I have ever witnessed. I hurried out in the rain to examine the stones and picked up several. These were nearly square flattish blocks, say from $\frac{3}{4}$ to 1 inch in length and breadth, and from $\frac{1}{4}$ to $\frac{1}{2}$ an inch in thickness. They suggested, by both shape and size, the ordinary 'chocolate caramels,' of the confectioner. There were some 8 or 10 persons, I think, in the station house with me, and several of these, observing my interest and enthusiasm, began to pick up the larger stones and bring them in to me and to my friend, Professor Hargrove, of Luray, Va. Soon larger and larger ones were thus collected, and I sought for means of measuring or weighing them. No rule or scales could be found, and

FIG. 1.

FIG. 2.

Outline of Hailstones that fell at Manassas, Va., August 10, 1897.

so we set ourselves, several of us, conjointly and carefully to estimate the dimensions. I recorded at the time one as being, honestly estimated, '2 inches long, 1½ inches wide and ¾ of an inch thick,' these being rather the average than the extreme dimensions.

It then occurred to me to make an outline drawing of the largest by laying it flat upon a page of my pocket memorandum and carefully running a pencil around it. I secured, in this way, a rather rough but fairly accurate outline of two. These outlines have been exactly copied (including some lines due to a slipping of the block or to a different inclination of the pencil) and are given in the accompanying cuts. The extreme lengths of these will be found to be, respectively, about 2½ and 3 inches; their extreme breadths about 1½ and 2 inches. The thickness of No. 1 was recorded at the time as being by estimate ¾ inch; that of No. 2 as being one inch. I estimate their volumes as about 1¾ cubic inches for No. 1 and nearly 3 cubic inches for No. 2. The drawing of No. 2 was done more hastily, as just in the midst of it my train rushed in and I had to leave. But I took my trophy with me, and, with perhaps pardonable enthusiasm, paraded it through the cars, and, exhibiting it to the passengers, asked expressions of opinions from them as to its size relatively to that of a popular object of comparison, a guinea egg. Perhaps 20 or 30 passengers agreed, without dissent, that it was as large or larger. Some said, 'It is as large as a hen's egg;' all agreed, also, that they had never seen so large a hailstone before. Upon breaking it to pieces, I found a sort of nucleus, of somewhat less transparent ice at the center, but observed no concentric layers or other marked structure of any kind; it was quite solid and tolerably transparent throughout. Both of these stones were characterized by blunt points or projections, as shown in the figures; and the sides also, while flat in the main, were uneven with low, rounded elevations and depressions of the same sort, the general thickness being fairly uniform.

I think that very few of these stones or blocks fell. Perhaps they would have been a yard or two apart as they lay on the ground. I think it likely also that the storm of hail was of brief duration, say 10 or 15 minutes, and that it embraced a very limited area.

It was, perhaps, about over when I took the train, as I infer from the fact that I have seen no account of it in the papers; and I found at the next station, only 5 miles off, that the road was dry and dusty.

I regret exceedingly that no more accurate observations seem to have been made of what must have been a most notable hailstorm, and I diffidently submit my own crude and imperfect account in the hope that thereby something further may be elicited in regard to it.

CHAS. H. WINSTON.

RICHMOND COLLEGE, VA.,
August 25, 1897.

THE DEATH OF VICTOR MEYER.

MANY years will pass before Heidelberg entirely recovers from the shock produced by the recent sudden death of Victor Meyer. That so great a man should depart in such a way, and in the prime of his life, seems to be the regret of all who knew his accomplishments.

The work of the semester was practically at an end and the majority of the students had left for the long vacation. It had been a very busy and fruitful period for the department. Every desk had been taken and many applicants turned away. Each student seemed proud of the privilege to work under such distinguished professors, chief among whom was Victor Meyer. His masterly leadership, scholarly attainments and genial manner were the constant inspiration of every one. On the 5th of August he had drawn to a close his annual course of lectures on experimental chemistry. After lingering for a moment to discuss the composition and decay of organic matter, and thanking his listeners for their faithfulness, he left the hall amid deafening and prolonged applause.

Returning from a social gathering rather late Saturday evening, he retired to his room, with the request that he be not disturbed on the following morning. When the door was forced open at noon by the anxious family he had already been dead some time, and the cyanide bottle by the bedside told the story.

When it was first reported that the beloved teacher had died by his own hand, not even his

most intimate friends would believe it, and to many the matter is still an enigma. He seemed too great a philosopher to countenance such an act. It is not improbable that temporary insanity shattered his mind. No expert opinion has been published. Although the fact was seldom noticeable, the great chemist was a very nervous man and had for an extended period been under medical treatment, but without great avail. During the previous winter he was forced to reduce the number of his lectures, but he persisted to the last in assuming all the responsibilities that fall upon a director of so large an institution. The strain was too great. For the last four days he was unable to sleep at all, and the man whose face was still as quiet and pleasant as ever was probably distracted by the fear that the physical forces which had served him so well were threatened with destruction. Only those who have suffered as he did can rightly judge the man. Certain it is that the annoying rumors, circulated by irresponsible reporters, are without any foundation. Of the two letters found on his desk, one expressed his love for his family in most endearing terms. The other was a farewell to his close friend, Kuehne, the famous physiologist.

On account of his expressed wish and because the semester had closed, elaborate ceremonies were avoided. As the quiet assemblage, including many famous scholars, stood around the grave, wreath after wreath was laid at its head. The venerable Bunsen, to whom Victor Meyer went at the age of sixteen to learn chemistry, sent a laurel from his home near by. Adolph von Baeyer came from Munich with a wreath 'to his best friend.' The German Chemical Society paid a tribute to its lost President, and the grand-ducal family of Baden sent a token. Among the many other wreaths was one bearing the words, 'Dem grossen Lehrer in Dankbarkeit, Seine Amerikanischen Schüler.' Heidelberg suffers a great loss, not only as a university, but as a city, for Victor Meyer was a citizen, as well as a scientist, and, while he was profoundly versed in every department of chemistry, he found time to encourage the development of the fine arts.

It is fortunate that there remain such splendid representatives of his school as those who have been his assistant professors. The vacant chair may not be filled for some months. Temporarily the direction of the laboratory is in the hands of Professor Gattermann, who is pushing so rapidly to the front of his science. The other professors, Jannasch, Auwers, Goldschmidt and Knoevenagel are all well-known investigators, and have their own large circles of admiring students.

H. C. Cooper.

Heidelberg, August 15, 1897.

THE ANTHROPOLOGICAL SESSION AT TORONTO.

It may be worth a few lines in Science to say a word in correction of the many erroneous and even ludicrous newspaper reports of the above meeting which suggest to the memory the famous definition of the crab by the French Academy before it was criticised by Cuvier.

The paleolithic or neolithic age of the New London stone axe was not a subject of discussion, as reported, simply because there was no room for two opinions on the matter. It is beyond all question neolithic, as every archæologist would be ready to assert at a glance.

Nor was any attempt made to prove that American man was older than European man, because again the evidence is so far absolutely conclusive on the other side. The paleoliths of Europe antedate all relics yet known from this continent.

Nor, thirdly, was any attempt made to prove the existence of preglacial man in America. The speakers who claimed the greatest antiquity advocated nothing more than a late glacial date for the oldest traces of human handiwork in this country.

As these three points formed the chief part of many of the reports of the meeting, it is easy to see how far short they fell of correctly representing the speakers.

E. W. Claypole.

SCIENTIFIC LITERATURE.

THE GENESIS OF THE DIAMOND.

There has recently been published a volume of small size, but of especial interest and importance, in regard to the origin of diamonds.

This is none other than the posthumous issue of the full papers of the late Professor H. Car-

vill Lewis, edited by his friend, Professor T. G. Bonney, of London.*

It will be remembered that Professor Lewis was the first to present a clear and definite theory of the origin of the South African diamonds, as resulting from the intrusion of igneous rocks into and through carbonaceous shales, and the crystallization of the carbon throughout the rock as it cooled, from hydrocarbons distilled from the shale that had been broken through. These views, now for the most part accepted, and subsequently confirmed by other and very interesting parallel discoveries, he presented in two papers read before the British Association for the Advancement of Science at its meetings held in 1886, at Birmingham, and in 1887, at Manchester. Before he was able, however, to prepare them for publication and carry them to the greater completeness that he desired, Professor Lewis succumbed to an attack of typhoid fever, which removed one of the most brilliant and capable of the rising scientists of this country. Agreeably to his expressed wishes, his material was entrusted to his friend and co-laborer, Professor George H. Williams, of Johns Hopkins University; but, by a strange fatality, before the latter had time to arrange and edit these papers this distinguished scientist also fell a victim to the same disease, in 1894. The work was then committed to Professor Bonney and is at last given to the scientific world.

The book consists of an introductory note by Mrs. Lewis; a preface by Professor Bonney; the two papers of Professor Lewis himself, with some later notices and references by the editor; a brief account of similar material from other localities, belonging to Professor Lewis—also by the editor; a closing note on some other MSS. of Professor Lewis, and a full index. There are also two plates and a number of smaller illustrations, the latter from Professor Lewis' own drawings.

*Papers and notes on the 'Genesis and Matrix of the Diamond.' By the late Henry Carvill Lewis, M.A., F.G.S., Professor of Mineralogy in the Academy of Natural Sciences, Philadelphia, Professor of Geology in Haverford College, U. S. A. Pages xvi + 72. 2 Plates. Edited from his unpublished MSS., by Professor T. G. Bonney, D.Sc. LL.D., F.R.S., &c. Longmans, Green & Co., London and Bombay. 1897.

The first paper, 'On a diamond-bearing peridotite and on the history of the diamond' (1886), is brief, dealing with the general character and occurrence of the diamantiferous rock at Kimberley, and outlining Professor Lewis' theory.

The second paper, 'The matrix of the diamond' (1887), is more extended and goes into an exhaustive discussion and comparison of the various aspects, contents and alterations of the rock, which he finds to be different from any previously described, and, therefore, proposes for it the name of Kimberlite. Its main character is that of a highly basic porphyritic peridotite, filled with olivine crystals and grains, more or less altered, and various other minerals—serpentine, tremolite, etc., with bronzite, rutile, perovskite, pyrope garnets, micaceous minerals and other forms, and at times brecciated in structure, filled with fragments of carbonaceous shale brought up from below. The shales are of Triassic age, the 'Karoo beds' of that region, and the intrusion of the peridotite in the great 'pipes' or chimneys that constitute the mines is therefore proved to be of a later, though not exactly determined period.

The question has sometimes been raised whether the diamonds themselves may not have been carried up from a deeper source in rocks below, instead of originating in the peridotite; and the occurrence of broken crystals has been cited in support of this view. Professor Lewis, however, disposes very completely of this idea in two ways: He refers to the well-known fact that each of the great mines or 'pipes' yields diamonds that have, in some respects, a type of character peculiar to that one and different from the others, so that African experts, and even those who have never been there, can recognize from which mine any diamond has come. Further, as to the broken crystals, he shows that breakage not unfrequently occurs after the diamonds are removed from the rock, and points out that this is a result of strain in their formation, as indicated by microscopical and optical examination, and that such a condition is known to produce ruptures and explosions in other minerals. It may be added here, although Professor Lewis does not speak of it, that many crystals must be broken in the blasting of the rock, the shoveling and the carting

of the loosened material, and the various mechanical processes employed at the mines, and that pieces of such broken crystals would be separated and scattered to various parts of the immense dumping and weathering floors, never to be recognized as fragments of the same one when finally recovered, perhaps at very different times.

The rock itself is a dark green, compact material, resembling serpentine and containing a large proportion of olivine, in grains and crystals; several green minerals that are not conspicuous, from the resemblance of their color to the ground-mass (enstatite, chrome-diopside, smaragdite and bastite); a mica, probably biotite, more conspicuous and quite abundant, and frequent grains of pyrope garnet, sometimes of gem quality and great beauty, and miscalled 'Cape Rubies.' Of smaller disseminated minerals are to be noted perovskite, quite frequent, and magnetite, chromite, ilmenite and picotite, less so, though common. Rare and minute occurrences are apatite, epidote, orthite, tremolite, tourmaline, rutile, sphene, leucoxene. As decomposition products there are serpentine and calcite, abundant, and zeolites, chalcedony and talc; also cyanite (?) These, with diamonds and included fragments of carbonaceous shale, make up the contents of this remarkable rock.

Professor Lewis then goes into a detailed account of the mode of occurrence of these minerals, beginning with the most conspicuous species—the olivine—which is remarkable for its fine cleavage-surfaces and very interesting in its alterations. These are chiefly (1) into serpentine, proceeding from without inward, and penetrating along crevices and fractures, also sometimes in the form of chrysotile, producing a velvety border or coating to the grain; (2) tremolite, more internal, the fibrous structure developing parallel to the vertical axis and domes of the olivine crystals; (3) when both these alterations are present and have gone so far as to obliterate most or all of the olivine, a talc-like substance intervenes between them in which are developed minute needles of rutile, arranged parallel to the faces of the olivine crystal. The rock contains every stage of these changes from pure bright unaltered olivine to those forms that have borders of serpentine or chrysotile, or incipient tremolite fibers within, to the complete alteration just described. The relation of all these to similar phenomena in other rocks, and in meteorites, is discussed with much fulness.

Professor Lewis then takes up the smaragdite, chrome-diopside, bastite and enstatite (or bronzite, for it is just on the line between the two varieties). The two first named are, in some cases, fine enough in color and clearness to yield gems, and also sometimes the bronzite; all are colored by chromium. The diopside occasionally gives rise to calcite by alteration.

The mica is next considered; as all who are familiar with the rock are aware, it is the most prominent of the contained minerals to the eye. It is somewhat anomalous in character, being chemically a biotite, but optically nearer to phlogopite. It occurs in several distinct ways: (1) as included crystalline masses or plates, apparently an original ingredient of the rock; (2) surrounding grains of pyrope; (3) rarely, as a result of the alteration of enstatite; and (4) as a metamorphic product from the included fragments of shale; and the first form has produced, by hydration, the vermiculite variety called vaalite, which occurs freely in the decomposed peridotite so largely known as the 'blue-ground.'

After referring to the pyrope garnets, and suggesting that the various garnetiferous serpentines are doubtless derived from the decomposition of similar peridotites, as further indicated by their likewise containing olivine, bronzite, chrome-diopside, etc., he mentions another variety of garnets as found in this rock, very small, very brilliant, very hard, colorless or greenish, and extremely difficult to distinguish from small diamonds. These Professor Lewis is inclined to refer to demantoid. (?)

An interesting part of this discussion next follows, in relation to the perovskite, which is pretty abundant in small crystals, of cubical habit. Professor Lewis gives much attention, and a number of drawings, to the optical features of this species, and strongly inclines to the view that regards perovskite as a highly twinned orthorhombic mineral and not isometric save in external aspect. This has long been a mooted point, and these observations are an

important contribution. Of much interest also are the chemical and genetic relations of this species as here presented; the crystals often enclose grains of what Professor Lewis terms a titanic spinellid, perhaps a titaniferous magnetite, perhaps ilmenite, indicating a derivation therefrom; they also, in some cases, lie in a curious manner, upon or around partially altered olivine crystals. The remark is made that, while perovskite is familiar in various non-feldspathic igneous rocks, it has not been found in peridotite until Professor Williams recognized it in the peculiar rock from Syracuse, N. Y., and that later Professor Lewis identified it in the similar rock from Isom's Creek, Kentucky, where it had been previously regarded as anatase. These three rocks, those just named and the African, are the only known occurrences of what is here named Kimberlite. The article goes on to show that in basic eruptive rocks the titanium takes the form of perovskite, while in acid rocks it forms sphene; in intermediate ones it develops ilmenite or titanic iron; and these deductions harmonize precisely with important experiments of Bourgeois, in the artificial production of titanium minerals.

After going into some particulars as to the minor minerals found in this rock, Professor Lewis then takes up the base or ground mass and discusses it minutely. He terms it 'a more or less homogeneous serpentinous mass,' very difficult to study by reason of its decomposed condition, consisting now of a mixture of serpentine with calcite and some other products of alteration, the original structure being wholly lost.

Fragmental enclosures are frequent, 'both of the adjoining shale and diabase, and also of more deeply seated granite, gneiss, eclogite, and other related rocks.' Of these the shale predominates, sometimes making the rock a breccia. The shale itself is highly charged with carbon, so as to be quite combustible; but the included fragments are altered, having lost their carbon and become harder, sometimes even metamorphosed to a micaceous structure, as before referred to. In size they vary from large masses, in the upper part of the mines, called by the workers 'floating-reef,' to small fragments, diminishing in number and size in descending.

Professor Lewis goes into very detailed petrographical and chemical discussion as to the original character of the rock, in which it is hardly possible to follow him in a review, and finding no known rock that presents identical characters, he proposes for it the name of Kimberlite. This he designates as 'a porphyritic volcanic peridotite of basaltic structure,' and notes three forms of its occurrence: (1) Kimberlite proper, a typical porphyritic lava; (2) Kimberlite breccia, the same rock broken and crushed by volcanic movements and crowded with included fragments of shale; (3) Kimberlite tuff, the fragmental and tufaceous portion of the same rock. These varieties graduate into each other, and all occur together in the same neck or crater, the second, however, being most abundant and most productive of diamonds.

He treats of the origin of the brecciated structure, which has caused much discussion, some geologists regarding the whole rock as a sort of tufa or volcanic mud, while others hold that it is a true outpouring lava that has carried up fragments of the rocks broken through it its course, and has since been largely decomposed. Professor Lewis urges the latter theory strongly, and supports it by many arguments; while the editor, Professor Bonney, evidently inclines to the other view, advocated by Professor W. H. Hudleston, in 1885, and by some others. There is not space here to review Professor Lewis' several arguments for the true igneous character of the Kimberlite and against the tufaceous theory. The one to which Professor Bonney accords the chief importance is the identity of the rock with that from Syracuse, New York, and Elliott county, Kentucky, where it occurs in actual dikes, such as are not found in tufas. The brecciated character, which is so marked, is referred by Professor Lewis to three causes, acting either separately or perhaps together. These are (1) rapid cooling and shrinkage; (2) 'friction brecciation,' from contact with the wall-rock; and (3) subsequent movements and explosions in the crater itself, below. He illustrates and parallels the first of these from meteorites, to some of which

this rock bears marked resemblance both in structure and contents, and the others from well-known occurrences in terrestrial volcanic rocks.

The third section of the volume is occupied with a detailed account, from specimens and notes of Professor Lewis, of the two other known occurrences of Kimberlite, at Syracuse, N. Y., and Willard, Ky. The identity of these with the African rock, in almost all particulars, is remarkable, and as they form definite eruptive dikes, Professor Lewis' view as to the latter is strongly confirmed.

It remains only to call attention to other and later facts which tend to bear out the views presented in this remarkable posthumous article.

The presence of a residual hydrocarbon in the rock of the African diamond mines was shown by an interesting and important observation of Sir Henry E. Roscoe (Proc. Lit. and Phil. Soc. of Manchester, XXIV., 1885, p. 5), which is alluded to by Professor Lewis in his second paper, and has frequently been cited in discussions of the subject. He found that the 'blue-ground' on treatment with hot water yielded an aromatic hydrocarbon, which he was able to separate by digesting the 'blue-ground' with ether and evaporating the solution. It then appeared as a crystalline aromatic solid, burning with a smoky flame (showing it rich in carbon), volatile, and melting at 50° C.

The bearing of this fact upon Professor Lewis' theory is clear. It indicates that the igneous rock, breaking through the highly carbonaceous Karoo shales (37.50 p. c. of carbon; Whitfield, U. S. Geological Survey; Gems and Prec. Stones North America, 1889, p. 33) became charged with volatilized hydrocarbons distilled from the shale, and that in cooling these had crystallized partly into diamonds and partly into the many carbonadoes, larger and smaller, which are distributed through the rock. Professor Roscoe's material strongly suggests this theory, which, indeed, he himself independently propounded.

In 1886 a meteorite fell at Novo Urei (September 22d) in the province of Pensa, Russia, which was found to contain about 1 per cent. of diamond carbon, in the form of gray particles.*

In 1887 Mr. Fletcher (*Mineralogical Magazine*, 7, 121) described the new mineral 'Cliftonite'—a black substance with a hardness of 2.5 and a density of 2.12, occurring in cubes with faces of the dodecahedron or tetrahexahedron in the meteorite of Youndegin, West Australia. This suggested a graphitic alteration of diamond—a view taken by Brezina (*Ann. Mus. Wien*, IV., 102, 1889) regarding this new species and certain graphitic crystals of cubic type, observed long before in the Arva meteorite and regarded as pseudomorphs after pyrite by Haidinger (Pogg., 67, 437, 1846), but later by Rose, as after diamond (*Beschr. Meteor.*, 40, 1864). Similar crystals were also known in the Sevier iron of Cocke county, Tenn.

In 1891 the discovery of diamond, or at least of diamond carbon, in some quantity in the meteoric iron of Cañon Diablo, Arizona, was announced by the late Professor A. E. Foote (*Amer. Jour. Science*, Vol. XLII., July, 1891, pp. 413–417) and Dr. George A. Koenig. In July, 1892 (Science, p. 15), Dr. O. W. Huntington gave further experiments on the same material, confirming the decisions of Professors Foote and Koenig; and in December of the same year similar results were published by M. C. Friedel (*Bulletin de la Soc. Francaise de Mineralogie*, No. 9, p. 258). A crucial test was then proposed by G. F. Kunz, of New York, and carried out in the presence of Dr. Huntington, at the World's Fair at Chicago, September 11, 1893, viz., the cutting of polished faces on pieces of diamond with some of the carbon powder from the cavities of the Cañon Diablo meteorite (*Amer. Jour. Sci.*, Vol. XLVI., December, 1893; and Min. Resources U. S., 1893, pp. 683–685).

In the meantime Professor Henri Moissan, of Paris, had been making his now celebrated experiments on the artificial production of diamonds from the cooling, under extreme pressure, of highly carbonated iron fused in a specially constructed electric furnace (Mineral Resources U. S., 1895, pp. 903–904).

All these facts taken together form a remarkable series of confirmatory evidence of the views advocated by our late countryman in re-

* Daubreé's discussion of the analogy of the occurrence of the diamond in the meteorites and in the South African Kimberlite was the next important paper on this subject. (Comptes Rendus, 110-18, 1890.)

gard to the production of this most precious of gems, the origin of which has been so obscure a problem in mineralogy and geology. Another point of great scientific interest developed in the course of these investigations is the close similarity, both in composition and in structure, existing between some of these rarer igneous rocks of our globe and the extra-terrestrial visitants that come to us from space.

Mr. G. F. Becker, in a recent letter, takes a different view of this subject and holds that I have misinterpreted Professor Lewis, and that he did not regard the diamonds as due to carbonaceous matter taken up from the shales. He claims that "Lewis over and over again says that the diamond is as much a part of the Kimberlite as its other component minerals." It is true that he did use such an expression of 'the Kimberley rock' (p. 44); but this is in summing up his argument that the diamonds are in their original matrix, as against the early notion of their having been washed into the 'kopjes' from above, or the later theories of their having been carried up with the igneous rock from some deeper source below. The statement relates merely to 'the matrix of the diamond'—the subject of the article—not to the source of the carbon. Moreover, diamonds are not present in the Kimberlite of Syracuse, N. Y., or of Elliott County, Kentucky,* which Professor Lewis recognized as the same rock. He says (p. 56): "In mineral composition, in eruptive character, in structure, in enclosures, the three rocks are identical." It is plain, therefore, that he did not regard diamonds as an essential ingredient of Kimberlite. As to their source being carbon derived from the shales, it is true that Professor Lewis does not in these papers distinctly so assert, though he refers frequently and pointedly to the association of diamonds with the penetrated and included shales. But in personal conversation, at a period between the dates of his two papers, and before he had even heard of the very suggestive experiment of Sir Henry Roscoe, Professor Lewis expressed to the writer his definite belief that such was their origin. The knowledge of this fact may have led me to state this view as held by Professor Lewis more clearly than appears on the face of his paper, and doubtless explains the perplexity that Mr. Becker expresses as to how he and I can read the article differently.

Mr. Becker says: "I consider the diamonds as much a part of the Kimberlite as zircons are a part of granites." This may be Mr. Becker's view; and he is a high authority, with whom I would not lightly disagree; but it can hardly be claimed as the view of Professor Lewis, when he asserts (as above noted) the absolute identity of the diamond-bearing Kimberlite of Africa with the non-diamond-bearing rocks of Syracuse and Kentucky. The question is not whether the diamonds (in Africa) are 'a part of the Kimberlite.' Undoubtedly they are so, there; but how came they to be so at that locality and not at the others? This subject was fully discussed by the writer in 'Gems and Precious Stones of North America,' pp. 32–34, in connection with the examinations made by Mr. Diller and myself in 1887, as to the possible occurrence of diamonds in Kentucky, as suggested by the similarity of the rock. It was there shown that, while the shales penetrated by the African Kimberlite had 37.50 per cent. of carbon, those traversed by the Kentucky Kimberlite contained but 0.68 per cent. The same rock breaks through a body of shale in two localities, the one rich in carbon, the other poor; the intruding rock is fitted with diamonds in the former case and none appear in the latter. And why did Lewis search everywhere for localities where serpentines and peridotites occurred associated with coal formations?

Professor Lewis observes (p. 8): "The rock (at Kimberley) appears in two types, one not bearing diamonds, the other diamantiferous, and the distinction between them is suggestive. Both occur in the same mine and are dark, compact, heavy rocks, closely resembling one another and differing mainly in the fact that one is free from enclosures of foreign substance, while the other is full of fragments of shale and other impurities. It is the latter which is diamantiferous." On p. 46 he notes the fact that the fragments of shale included in the igneous rock have lost their carbonaceous matter; and

* Is there a diamond field in Kentucky? J. S. Diller-G. F. Kunz, SCIENCE, Vol. X., 1887, pp. 140–142.

on p. 51 he cites as of great interest the observation and experiment of Professor Roscoe, elsewhere noted, as to the extraction of a hydrocarbon from the 'blue ground.' These references alone would indicate Professor Lewis' views, even apart from his own statement of them to the writer.

Mr. Becker also alludes to the broken crystals, as repeatedly seen by him in separate fragments enclosed or embedded in the rock, and as not being considered rarities at Kimberley. These occurrences, however, may well be due to the very causes treated of by Professor Lewis in explaining the brecciated character of the rock (p. 54 and above noted), especially the first and third, the latter in particular, 'subsequent explosions and movements in the crater' below. Any such action sufficient to break up the Kimberlite into the likeness of a breccia would easily shatter the highly cleavable diamond crystals and bring about the condition seen and described by Mr. Becker.

It may not be out of place here to recall an instance where, in another locality, the occurrence of diamond may be connected with a similar outbreak of igneous rock through beds containing carbon. In a paper, 'On Bohemian Garnets,' read by me before the American Institute of Mining Engineers, and published in their Transactions for February, 1892, mention was made of a diamond crystal found in 1870 at Dlaschkowitz, Bohemia, among a number of the pyrope garnets which are derived from the decomposition of peridotite rock. After being disputed and identified, it was deposited in the public museum at Prague, where I examined it, as well as the locality where it was found. The decomposed serpentinous rock has evidently been transported from the north (probably by glacial action) and there are found, at a distance of twenty or thirty miles in that direction, basaltic outflows that have broken through the coal measures. Here, again, is a suggestion of similar conditions, and the occurrence of this single crystal is not without interest in such a connection, as may be a Ural crystal at Chitanka, where I identified serpentine and pyrope, but not any carbonaceous materials, as my time was very limited.

It is a matter for national pride that this remarkable investigation should have been made by an American scientist; and a debt of gratitude is due both to the great English meteorologist—the editor, Professor Bonney—for his labor of love, alike to science and to a deceased friend, and also to Mrs. Lewis, who has so carefully sought to prepare and make public these papers of her brilliant and lamented husband.

George F. Kunz.

New York.

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